IN THE UNITED STATES PATENT & TRADEMARK OFFICE

In re Reissue Application of Proctor
Reissue Application No. 09/773,303
Filed: 31 January 2001
For: U.S. Patent No. 5,894,079

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In re Proctor Reexamination Proceeding
Control No. 90/005,892
Filed: December 20, 2000
For: U.S. Patent No. 5,894,079
Title: FIELD BEAN CULTIVAR NAMED ENOLA

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Dated: October 14, 2005

DECLARATION OF POLLY A. PROCTOR

1. My name is Polly A. Proctor. My address is P.O. Box 138, 1281 Pinion, Delta, Colorado 81416. I am a Vice President of Pod-Ners L.L.C, the owner of United States Patent No. 5,894,079, the patent involved in these consolidated proceedings. I am the same Polly A. Proctor that signed Declarations in this matter on March 25, 2003 and May 28, 2004.

2. I have been using the Munsell Book of Colors to read colors displayed by bean plants and seeds since at least 1999. Most of my efforts have focused on bean colors, the seed coat and hilar ring in particular. I have read the colors of several thousand bean seeds since 1999. I have been involved in other color matching activities since the early 1970's, when I matched sugar samples to reference samples for Great Western Sugar. In 1984 (and since), I have been involved in a

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landscape business that requires matching the colors of plants, flowers, trees shrubs and inanimate objects of various sorts.

3. I have used the Munsell Book of Color because it was one of two references recommended by the Plant Variety Protection Office when we applied for a Plant Variety Protection Certificate for the Enola bean. I understood at the time that the Munsell Book of Color was a widely used tool for color analysis, and I believe that still to be the case. See Attachments 1 and 2. One reference states that the Munsell system is "the simplest and most widely used subjective color system." See Attachment 3.

3. In 2002, I visited the facility of the Munsell Color Services, which is a division of GretagMacBeth, L.L.C. I met with Mr. Luis A. Vega, a Senior Color Technologist with Munsell Color Services. Among other things, we discussed techniques for reading color using the Munsell Book of Color. He confirmed my belief that I was conducting the analysis properly.

4. While I was at Munsell, I took the FM (for Farnsworth-Munsell) 100 Hue Test. Munsell describes the test on its website: " This test gives you an easy-to-administer but highly effective method for measuring any individual's color vision. Used by the government and industry for over 40 years, the test consists of four trays containing a total of 85 removable color reference caps (incremental hue variation) spanning the visible spectrum. Color vision abnormalities and aptitude are detected by the ability of the test subject to place the color caps in order of hue." See Attachment 4 (includes Manual) and http://www.munsell.com/index/products/products_color-standards/products_color-vision-tests/products_fm-100-hue-test.htm.

5. My score on the test was 84 out of 85. Mr. Vega stated that this was a score that would be made by someone qualified to be a professional colorist.

6. One important aspect of Munsell Color measurement is the light conditions under which the reading is taken. Outdoor light has a blue tint in the morning and a reddish tint in the evening. In addition, direct sunlight is too bright to permit readings.

7. My practice is to take my readings between the hours of 10:00 AM and 2:00 PM. I sit in front of a north-facing window. Beyond that, my observations generally follow the procedure found in ASTM D 1535-01, which specifies a standard practice for Munsell Color analysis in daylight by an observer having normal color vision. Attachment 5. I do not follow each and every requirements of the ASTM standard because I have found, after years of involvement in color matching, that a few of them have no effect on the accuracy of my readings (south window - southern hemisphere does not apply; canopy of black cloth has no bearing one way or the other; use of gloss edition does not work well; and #8. on page 3 of the 'Standard' is of no use).

8. Mr. Vega at Munsell told me that Munsell prefers that daylight-based measurements be taken under lightly overcast skies. See also Attachments 4 and 6. In Delta, however, bright days are the norm, and I take my measurements on bright days only to maintain consistency. Mr. Vega had no problem with this.

8. I make my measurements by looking at one object at a time. I am not aware of any color measurement system where two objects are simultaneously compared to a color chart, and that is definitively not the case with the Munsell system. The reference on Attachment 3 to "adjacent samples" is a reference to adjacent Munsell reference color samples, not to samples that one is trying to read.

9. The Examiner asks about the information provided by me on PI 282060, PI 312090 and PI 208777, stating that they could not be evaluated because my first table does not specify whether the colors I read are for the seed coat or the hilar ring. The answer is that they relate to the seed coat.

10. I make these statements under penalty of perjury.

October 14, 2005

Polly A. Proctor

Attachment 1

Charting Color from the Eye of the Beholder

A century ago, artist Albert Henry Munsell quantified colors based on how they appear to people; specializations of his system are still in wide scientific use

Edward R. Landa and Mark D. Fairchild

Say the phrase "school bus" to any American, and the image sure to spring to mind is a vehicle of a particular color—a standard yellow that is one of the most easily recognized and evocative product colors in the United States. But how is it that all school buses across the country are exactly the same yellow color?

It is neither practical nor feasible for all school buses to be painted with the same batch of paint. Instead, specific color standards exist that assure that all paint manufactured for school buses is within a color tolerance—and that the color stays within that tolerance when the paint is applied to the bus.

Where do such standards come from? Are they simply calculations made by a physicist or chemist wielding a spectrometer? When it comes to the colors that we use in life, the answer is not that straightforward. It is common to say that certain wavelengths of the electromagnetic spectrum are a given color, but in truth, it is more correct to say that those stimuli are *perceived* to be of a certain color when viewed under specific conditions. So without the human observer, there is really no color, and practical standards for color must take this factor of human perception into account.

The work of mapping human color perception began in earnest in the 19th century. This year marks the centenary of the first atlas of color, by an artist named Albert Henry Munsell.

Munsell's vision of a systematic way to communicate color appearance has had an impact on essentially all modern systems of color measurement and specification. Today a school-bus manufacturer, for example, has access to a numerical standard based on instrumental measurements of the spectral reflectance characteristics of the paint. Undergirding these numbers are colorimetric computations based on a system called CIE, for Commission Internationale de L'Éclairage, or International Commission on Illumination. These instrumental specifications and tolerances allow paint and pigment manufacturers to formulate paint that matches the desired school-bus color more easily. CIE charts of these numbers are also backed up with physical samples that show the optimal school-bus yellow as well as limits along the perceptual color dimensions of lightness-darkness, hue and chroma (or how much the apparent hue differs from neutral gray)—the dimensions first described and measured by Albert Munsell.

Such systems are used to create and control almost every colored product. Examples include the textiles clothes are made of, the inks used in printers, the encoding of digital television signals, the colors of signal lights, the proper cooking times for French fries, the pearlescent paints on automobiles that change color with angle, the color of the beer at the local pub and the colors of crayons that children carry off of school buses to create art in school.

A Colorful History

Color description was an interesting problem to scientists and artists in the 19th and early 20th centuries, engaging scholars such as Germany's Johann Wolfgang von Goethe and Wilhelm Ostwald, and the American printer and educational reformer Milton Bradley, best known today for his board games.

Munsell's interest in the description of color began in 1879, while he was a student at the Massachusetts Normal Art School (MNAS, now the Massachusetts College of Art), when he read the then-just-published text *Modern Chromatics with Application to Art and Industry* by Columbia University physicist Ogden Rood.

Although Munsell was certainly influenced and motivated by the color systems reviewed in Rood's book, his own system would have several features that had not been previously described, most importantly the relations

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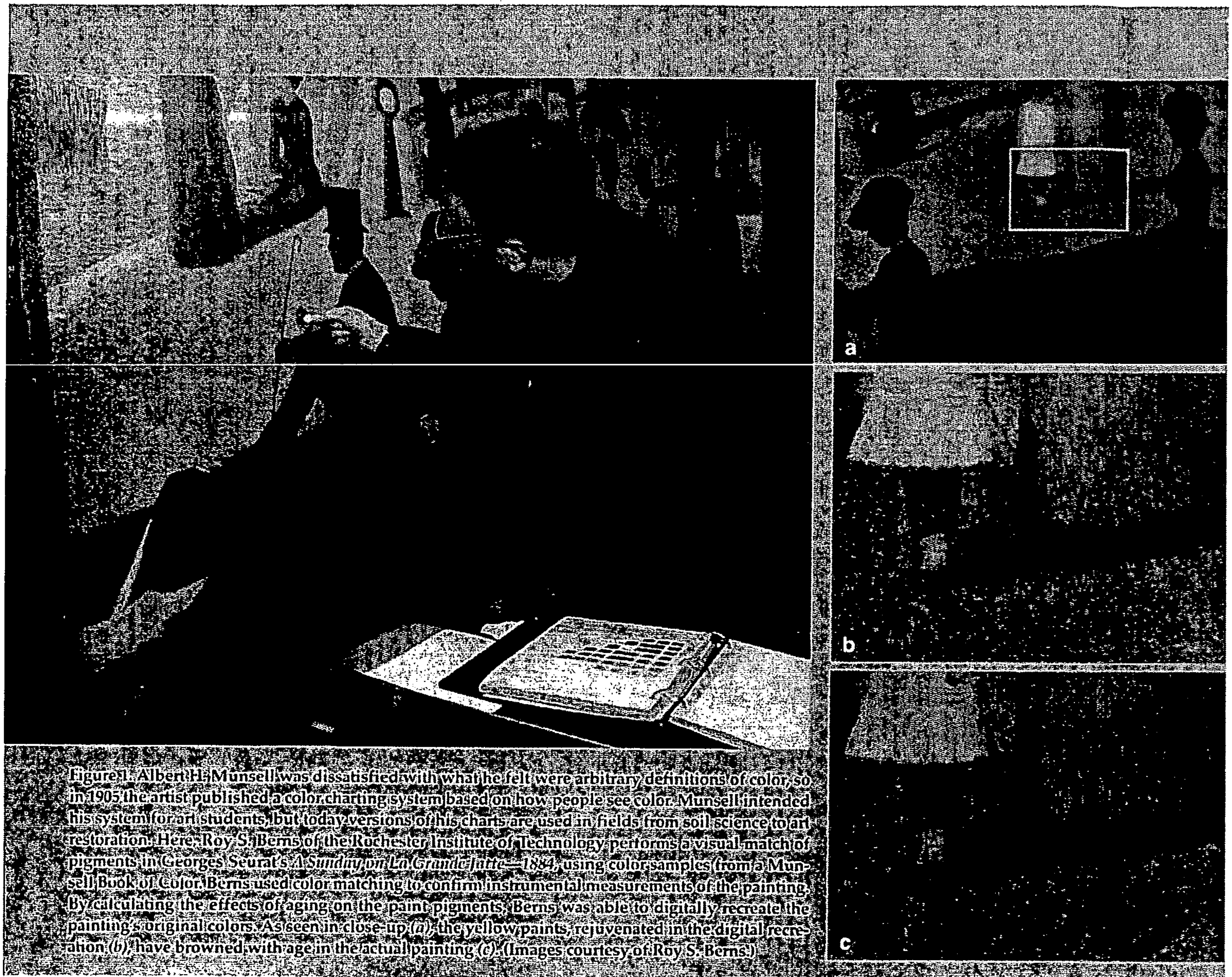

Figure 1. Albert H. Munsell was dissatisfied with what he felt were arbitrary definitions of color, so in 1905 the artist published a color charting system based on how people see color. Munsell intended his system for art students, but today versions of his charts are used in fields from soil science to art restoration. Here, Roy S. Berns of the Rochester Institute of Technology performs a visual match of pigments in Georges Seurat's *A Sunday on La Grande Jatte—1884*, using color samples from a Munsell Book of Color. Berns used color matching to confirm instrumental measurements of the painting. By calculating the effects of aging on the paint pigments, Berns was able to digitally recreate the painting's original colors. As seen in close-up (*a*), the yellow paints, rejuvenated in the digital recreation (*b*), have browned with age in the actual painting (*c*). (Images courtesy of Roy S. Berns.)

between lightness, luminous intensity and maximum colorfulness.

After his graduation in 1881, Munsell became an instructor at MNAS, specializing in artistic anatomy and color composition. In 1892, while sketching in Venice with Boston artist Denman Ross, Munsell noted in his diary that they discussed the need for a "systematic color scheme for painters" to prepare mentally and sequentially for the laying of the palette (Ross, who taught art at Harvard, would go on to develop his own color system with a nine-step value scale in 1907).

Munsell was not satisfied with color descriptions of the day, such as "topazy yellow" or "Indian red." His quantitative research in the field seems to have begun on a summer vacation in 1898, when, to create a teaching aid for his color-composition students, he worked on distinct designations of colors and their display on wheels and spheres.

His first model used a child's globe as a base for rotary color mixtures. With the globes, Munsell was able to create and demonstrate colors of various hues that had equal lightness and chromatic balance such that they mixed to a neutral gray when the globes were spun. This allowed Munsell to demonstrate his concepts for an impressed Rood, who stated that Munsell "put an artistic idea into scientific form." Munsell also later created a portable visual photometer to allow him to accurately scale the perceived lightness of chromatic colors through visual matching to a gray scale.

Munsell's artwork focused mostly on portraits and seascapes. His painting of Helen Keller hangs in the American Foundation for the Blind headquarters in New York City. A view from the Roosevelt summer home at Campobello, painted by Munsell for the family in 1890, is displayed in the office of Franklin Delano Roosevelt's mother at Hyde Park, New York. Thus, he was well known in the art world, but as he developed his color system, Munsell also moved easily among the science and engineering faculties in Boston. He consulted with individuals such as the noted physiologist Henry Pickering Bowditch at Harvard Medical School.

In 1905, intent on the goal that "color anarchy is replaced by systematic color description," Munsell published the first edition of his 67-page text *A Color Notation*, which described the Munsell Color System and its specification of color by measured scales of hue, value and chroma. H. E. Clifford, Gordon McKay Professor of Electrical Engineering at Harvard, provided an introduction to this volume.

Although Munsell honed his color system within a circle of scientists, he saw its broad application in general society, and his color spheres reached a wide audience. For example, around

1901, William Filene of Filene's Department Store asked Munsell to show the color sphere to the Shopkeepers' Association in Boston. In the 1920s, the Filene Company underwrote the cost of a color chart prepared by the Munsell Color Company for use in the clothing industry. At about the same time, another early Munsell color sphere was on display and available for study at the Physical Laboratory of Columbia University.

Munsell's health declined rapidly after a 1914 trip to Europe. He underwent surgery for appendicitis in May 1917. Later that year, he gave up the studio he had occupied since 1901; several months later it was taken over by the painter John Singer Sargent. Munsell died on June 28, 1918, at age 60. The Munsell Color Company, which was established circa 1917, carried on the commercialization of his work, selling color charts and other products under the leadership of his son Alexander Ector Orr Munsell.

Through 1946, 15 editions of *A Color Notation* were published by the Munsell Color Company. Other books followed, including the *Atlas of the Munsell Color System* published in 1915, and *A Grammar of Color*, published posthumously in 1921. No other color system from this time period has been as long-lived, commercially successful or influential.

Dorothy Nickerson, who began her career as A. E. O. Munsell's secretary and laboratory assistant in 1921, did much to adapt the Munsell Color System to commercial applications and to describe its scientific basis. Her work included extensive involvement on the Optical Society of America Colorimetry Committee and historical publications on the Munsell System. Nickerson authored more than 150 papers and rose to prominence within the Inter-Society Color Council, which established its Nickerson Award in 1980.

The legacy of color research pioneered by A. H. Munsell is today honored by the Munsell Color Science Laboratory, founded at the Rochester Institute of Technology in 1983.

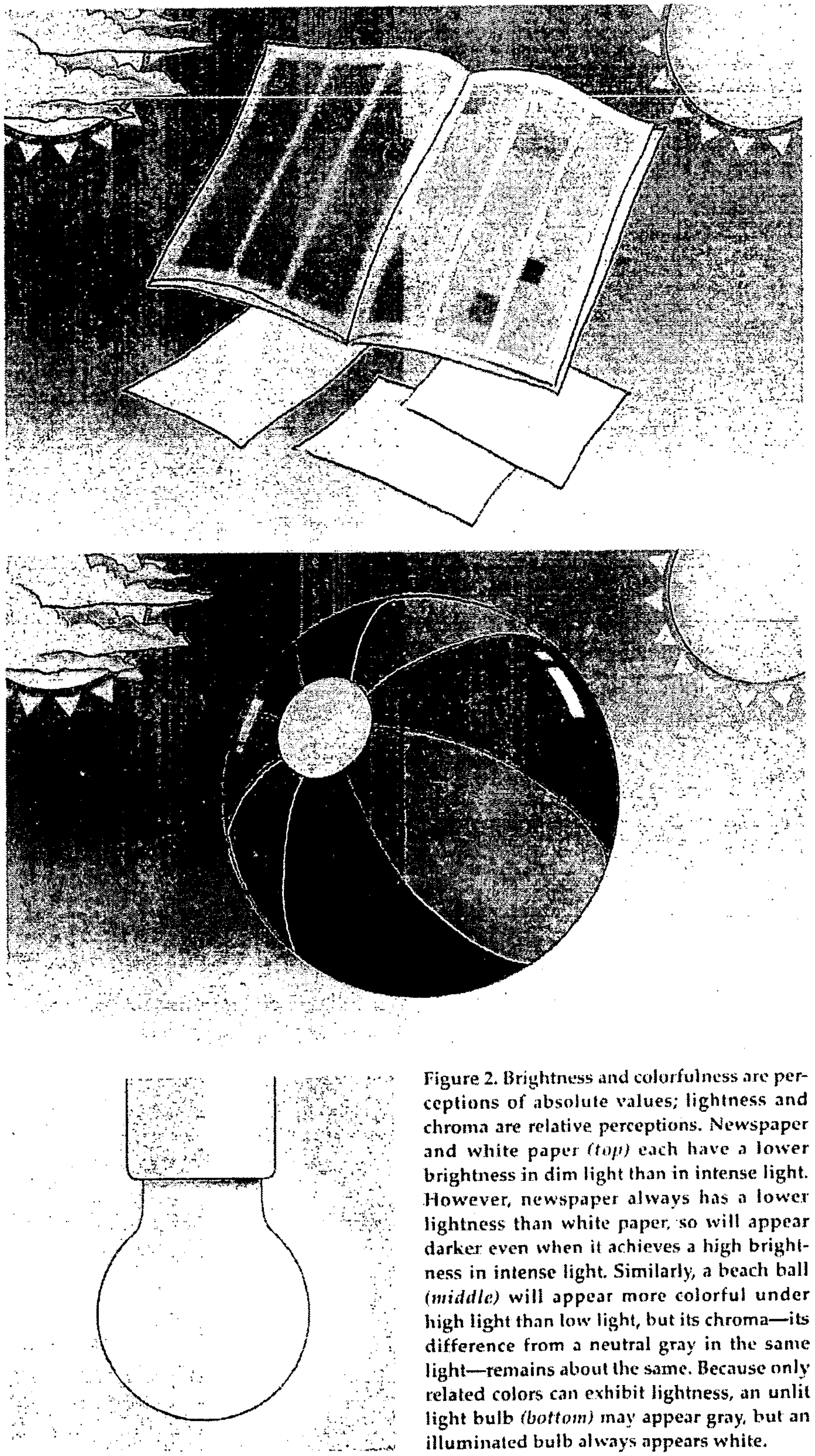

Figure 2. Brightness and colorfulness are perceptions of absolute values; lightness and chroma are relative perceptions. Newspaper and white paper *(top)* each have a lower brightness in dim light than in intense light. However, newspaper always has a lower lightness than white paper, so will appear darker even when it achieves a high brightness in intense light. Similarly, a beach ball *(middle)* will appear more colorful under high light than low light, but its chroma—its difference from a neutral gray in the same light—remains about the same. Because only related colors can exhibit lightness, an unlit light bulb *(bottom)* may appear gray, but an illuminated bulb always appears white.

Defining Color

In any field of study, it is important to have a standard vocabulary. In the study of color this vocabulary is often muddled, as terms such as "lightness" and "brightness" are casually interchanged. Even in education, treatment of color is inconsistent. To the grade-school child, color might be made up of three primaries: red, blue and yellow. The printer is taught that the three primaries are cyan, magenta and yellow, whereas the television engineer is taught that color is made up of red, green and blue. Finally, the physicist might be taught that colors are divisions of the visible portion of the electromagnetic spectrum. Although each of these concepts of color is correct in its context, it is incorrect in others.

In the field of color science, the *de facto* standard for vocabulary comes from the International Lighting Vocabulary, published by the CIE, which clarifies the distinctions in various dimensions of color experience. These terms scientifically and unambiguously define the

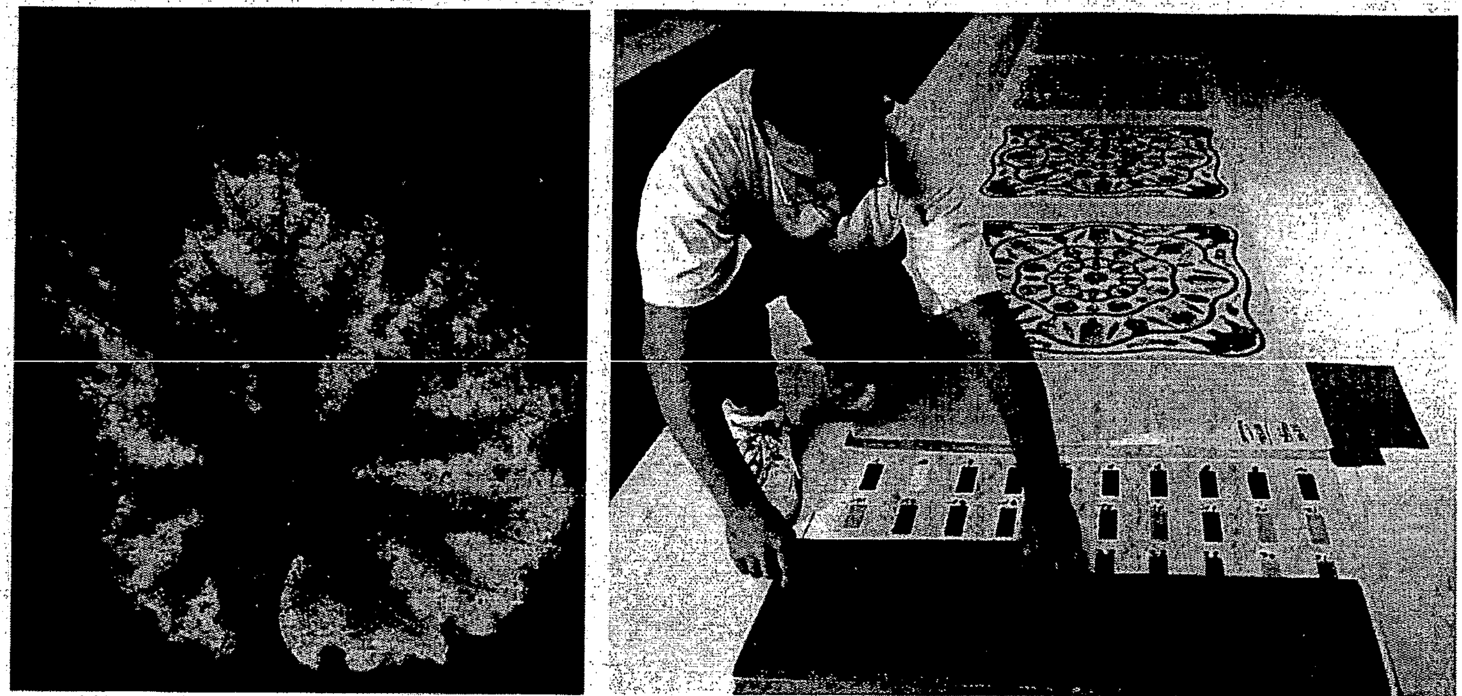

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Figure 3. Variants of Munsell's color system are in wide use in many areas of science and technology. Botanists use Munsell Plant Tissue Charts in plant taxonomic classification and for the identification of plant diseases that lead to tissue discoloration, such as potassium deficiency in a grape plant *(left)*. Fabric dyers use color charts to select colors and to keep their products consistent from print to print *(right)*.

perceptual attributes that Munsell notated in his system. As such, the focus is on the object-surface color descriptors of *lightness*, *chroma* and *hue* that are those defined in Munsell's system. But first one must define the term "color" itself.

Few people, when asked, can give a precise definition of what exactly color is. It is almost impossible to do without using an example. Even the CIE resorted to the inclusion of color names in its definition of color. The most critical part of the formal definition of color to keep in mind is that it is an "attribute of visual perception"—a description of color appearance to human observers.

However, it is known that color perception varies somewhat from person to person—and within individuals during their lifetimes. For instance, as the eye's lens hardens from aging, it absorbs and scatters more short-wavelength colors, so the visual system looks through a filter that yellows increasingly with age.

With highly variable human observers having such a central role in color models, one might wonder how accurate color measurements can be made. Careful experimentation has quantified the human visual response to color and defined mathematical equivalents of average human color perception, creating "standard observers" that can be used to simulate the human visual response to color computationally. Such systems have been standardized for nearly 75 years and are very successful in both scientific research and practical applications.

Munsell resisted some suggestions to tie his system to physical scales of wavelength because he realized this was not feasible. Instead he focused on developing a system that quantitatively and systematically described the overall appearance of colors. Color scientists to this day work to create mathematical simulations as accurate as Munsell's quantification of visual observations. That is why, despite significant advances in the theory and technology of color measurement, human observers are still used as the final

Figure 4. Dorothy Nickerson *(left)* was a tireless advocate and researcher for the color system established by Albert Munsell *(right)*. On her death in 1985, noted color scientist David L. MacAdam of the University of Rochester wrote "Alas, the prophetess of color—inspired by Munsell—is silent." (Photographs courtesy of the Munsell Color Science Laboratory.)

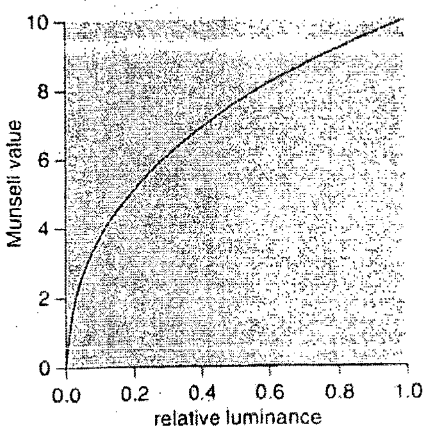


Figure 5. Color systems based on perception have a complicated relation to physical color measurement. Many combinations of wavelengths can sum to the same perceived color; for this reason, Munsell concentrated solely on color perception for the basis of his system. Munsell value, or lightness, does not increase linearly with luminance. A sample that the human visual system perceives as a middle gray (with a value of 5 in the Munsell system) has a relative luminance of about 20 percent (100 percent would look white). The relation between the other two dimensions of the Munsell system, hue and chroma, is even more complicated to relate to physical measurements of light, such as wavelength.

judges of colored products to confirm instrumental results.

Of the properties defined by Munsell, *hue* is perhaps the easiest of the color terms to understand. It is defined as the similarity of a perception to one of the perceived colors—red, yellow, green and blue—or to a combination of two of them. Hue is often described with a *hue circle*, and this is indeed the way it is described in the Munsell system.

One important point of this description, and the definition given by the CIE, is that there are unique hues—again, red, yellow, green and blue—that follow the opponent color theory first postulated by Ewald Hering in the late 1800s. Hering noted that certain hues were never perceived together, such as reddish-green or yellowish-blue. This formulated the fundamental notion that human color vision is encoded into red-green and blue-yellow channels.

Munsell's hue designation is consistent with this theory but adds a fifth principal hue, purple, to achieve another desired property: equality of perceptual hue spacing for the entire hue circle. This equality of spacing means that the perceived change in hue is equal for each equal numerical step in the Munsell hue designation. Another reason Munsell added purple as a principal hue is that there are a lot of perceptible hue steps between our perceived unique red and unique blue hues. In other words, we can discriminate many purple hues but not so many yellowish-green hues.

The attributes of *brightness* and *lightness* are very often interchanged, despite the fact that they have distinct definitions. Brightness refers to the absolute perception of the amount of light of a stimulus, while lightness can be thought of as the relative brightness. In other words, lightness is our perception of the brightness of an object relative to the brightness of an object that appears white to the human eye under similar illumination. The human visual system generally behaves as a lightness, not a brightness, detector, which can perhaps be better described with an example.

A typical newspaper, when read indoors, has a certain brightness and lightness. When viewed side by side with standard office paper, the newsprint often looks slightly gray, while the office paper appears white. When the newsprint and office paper are brought outdoors on a sunny day, they both have a much higher brightness. Yet the newsprint still appears darker than the office paper because it has a lower lightness. The amount of light reflected from the newsprint outdoors might be more than a hundred times greater than the office paper was indoors, yet the relative amount of light reflected when comparing the two has not changed with the change in illumination. Thus, the difference in brightness between the two papers, or their lightness, has not changed. The Munsell value scale is a scale of lightness.

As an interesting note, only *related colors* can exhibit lightness. *Related colors* are colors seen and judged in relation to other similarly illuminated colors. This is the reason that there cannot be a gray light bulb. When illuminated and viewed in isolation, the light bulb is the brightest stimulus in the field of view and thus appears white.

The definitions of *colorfulness* and *chroma* are very similar to those of brightness and lightness in that colorfulness is an absolute perception, whereas chroma is relative. Essentially, colorfulness describes the amount, or intensity, of the hue of a color stimulus. A gray stimulus has no colorfulness, while a vivid red would be high in colorfulness (and of red hue). Similarly, chroma is to colorfulness as lightness is to brightness.

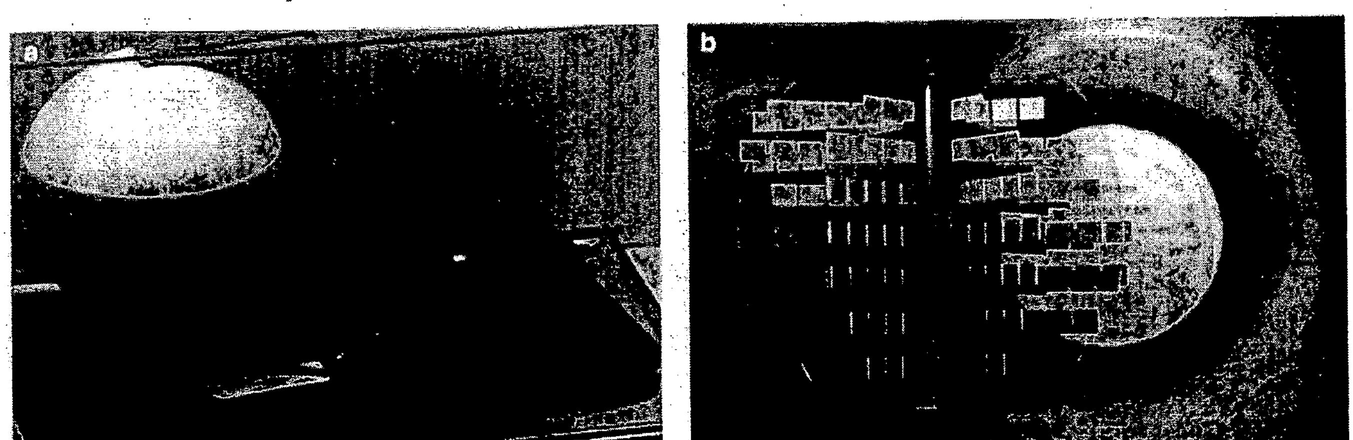


Figure 6. Munsell's first color models used globes *(a)* as a base for rotary color mixtures, such that the five hues of equal lightness (called "value" by Munsell) and chroma appeared as a neutral gray when the globe was spun. Later versions used a "tree" in which value increased from bottom to top, and chroma on every hue "branch" increased from center to edge *(b)*. A Nickerson color fan, behind the Munsell tree, shows the maximum chroma for 40 hues at different values. Munsell published his original volumes in 1905 and 1915, for which he created color samples from his own visual observations. Later editions *(c, facing page)* involved more detailed experimentation and contained a more

As with lightness, the human visual system generally behaves as a chroma detector. When we take a colored object out into bright sunlight from a dim room, it appears more colorful. But its chroma remains approximately constant, since the brightness of a white stimulus under the same conditions increases along with the colorfulness of the stimulus.

Making Color a System

Munsell chose to create his color system around the perceptual attributes of lightness (called Munsell value), hue and chroma because they are the three dimensions that relate most closely to our everyday experience of the colors of objects. Our visual system adapts to incredibly large changes in the color and level of illumination to help us perceive object colors as relatively stable. Thus a perceptual color system such as the Munsell system is most useful if it is enumerated in terms of the perceptual color dimensions most closely related to these relatively stable object perceptions.

One representation of the Munsell system is called a Munsell tree. The "trunk" of the tree is the value scale with dark at the bottom and light at the top. Each "branch" represents a different hue, and the "leaves" on the branches increase in chroma with distance from the center of the tree. In the Munsell system, each color is designated by its hue (with a set of letters and numbers), its value (with a number ranging from 0 to 10) and its chroma (with a number ranging from 0 for neutral grays to numbers on the order of 15 or so for the highest chroma samples; the actual maximum chroma available depends on the particular hue and value chosen).

For example, a deep red sports car might have the Munsell designation of 4R 3/12, where 4R hue designates a hue just slightly more bluish than a unique red, value 3 indicates a slightly dark color (value 5 is perceptually midway between white and black in lightness), and chroma 12 indicates that it is a vivid red.

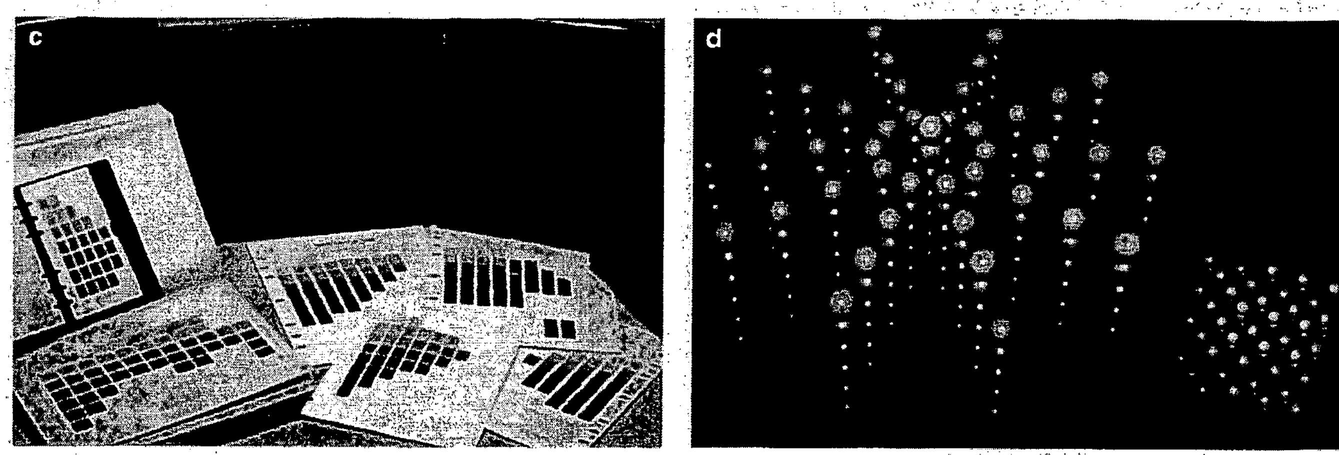
An important part of Munsell's approach to building a color system was that he created each scale of a perceptual color dimension to have equal numerical increments perceptually. He divided the hue circle into 100 equal perceived hue steps and anchored it with five principal hues (red, yellow, green, blue and purple) and five intermediate hues. For each of those 10 hues, he created 10 additional smaller increments. In addition, Munsell chroma steps are about half the size of the value steps, such that a change of one step in value appears about the same magnitude in color difference as two steps in chroma.

Although the colors of the Munsell system are specified by their appearance in terms of value, chroma and hue, once samples for each designation are created, the system can be recorded and reproduced using physical metrics of color. Specifically, the spectral reflectance of the samples and the spectral power distribution of the illumination are used together with standard human response functions to designate physical color coordinates known as *tristimulus values*, which are directly related to the stimulus wavelength and energy. These coordinates ultimately define the system and allow reproduction of nominal-color samples. Such numerical color specifications allow the system to continue to be recreated even if the samples of a current embodiment should fade or be otherwise damaged.

The visual uniformity of the Munsell system has been one of the most significant attributes in making it one of the most important and influential color specifications of the last century. The first color samples in his 1915 atlas were created by Munsell himself through his own visual observations. The 1929 *Munsell Book of Color* represents a more systematic definition of the color samples than the 1905 atlas through more detailed experimentation. It can really be thought of as the classic edition of the Munsell book that brought the system into the forefront of color science.

Although the 1929 *Munsell Book of Color* was certainly a success, it was recognized that the color chips embodying the system did not accurately match the theory for all of the samples in the book (generally about 1,500 color samples). The Optical Society of America's Colorimetry Committee—with critical contributions from Dorothy Nickerson—performed visual experiments, using more than 300,000 visual observations, to create a more accurate specification of the system in terms of instrumental color measurement. Their results were published in the 1940s and referred to as the *Munsell renotation*, which is also the current definition of the samples in the *Munsell Book of Color*.

The Munsell system evolved simultaneously with instrumental color-



systematic definition of color samples. In the 1940s the Optical Society of America undertook another revision of the Munsell color samples, creating the current standard. Modern representations of Munsell samples *(d)* include a computer rendering of the Munsell tree, shown here with a more recent color system, the OSA Uniform Color Scales, which describes the same colors in a different mathematical way. Rather than treating each of the three dimensions of color separately, as Munsell did, this system is designed to provide equal perceptual spacing in all three dimensions simultaneously. (Images courtesy of the authors.)

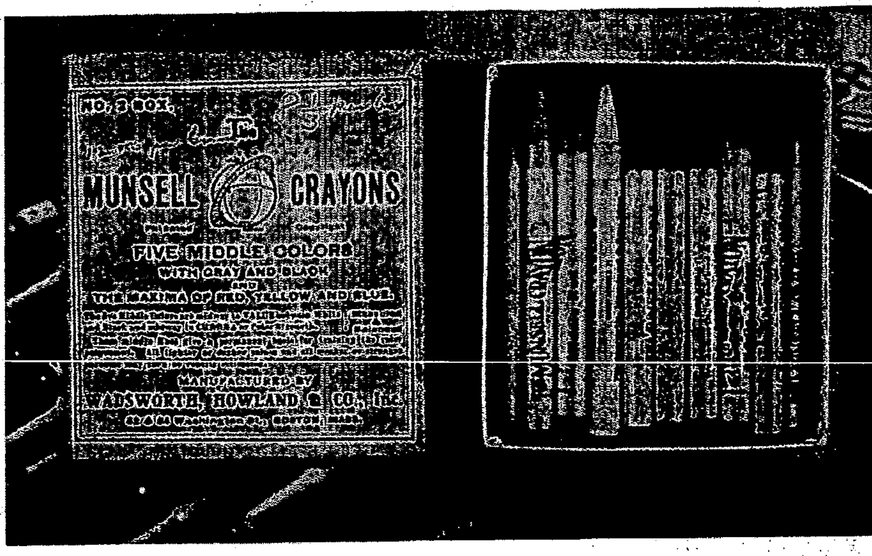


Figure 7. One of the first color products that Munsell had manufactured was a set of crayons. This set showed colors with a mid-level value and chroma. Munsell sold his crayons to the company that now manufactures Crayola crayons, whose color names do not reflect Munsell's systematic approach to color. (Photograph of Munsell crayons reproduced by the permission of The Huntington Library, San Marino, California; photo-montage courtesy of the authors.)

measurement techniques (the CIE system of colorimetry). The Munsell system was improved through the use of instrumental techniques to specify and produce modern Munsell samples, and instrumental colorimetry benefited from the visual data on color-attribute scaling (measurements of quantitative magnitudes of our perceptions) provided by the Munsell system.

Today, the most widely used computational color system for color material specification and tolerances is the CIELAB color space, originally published by the CIE in 1976. This color space has three dimensions to describe object color appearance. In rectangular coordinates, the dimensions are L^* (lightness), a^* (redness-greenness) and b^* (yellowness-blueness). An alternative representation of the same color space is in the cylindrical coordinate system of L^* (lightness), C^*_{ab} (chroma) and h_{ab} (hue angle) that corresponds with the dimensions of the Munsell system.

CIELAB has been successful in its 30 years of existence, but color science has not stood still. Current research aims to extend the CIELAB mathematical model to improve our ability to predict the appearance of colored stimuli and images under a wide variety of viewing conditions. Mathematical models attempting this complex task are known as color appearance models. The most recent, internationally accepted, model of color appearance is known as CIECAM02, for the *CIE 2002 Color Appearance Model*. Modern computer-graphic renderings of both the Munsell system and other systems of color specification in proposed mathematical color spaces are a great aid in the formulation of these new models of color measurement.

Munsell's Extensive Reach

Albert Munsell originally set out to build a color system as a way to improve his teaching about color to his own art students, but it is clear that his system has had a significant impact on the art and science of color. Some areas where Munsell products are currently used include imaging-system calibration and characterization, evaluation of color vision for color deficiencies, botany for the classification of certain plant diseases and nutrient deficiencies, color coding of electrical wire and cable, food standard colors to assess the quality of French fries, olives, tomatoes, cherries and pumpkins, American National Standards Institute (ANSI) safety colors and the description of skin, hair and eye color in forensic pathology.

Even crayons have an interesting relation to the work of Munsell. The colors of the crayons themselves are standardized and controlled using colorimetric techniques similar to those described above for school buses. In addition, one of the first color products that Munsell had manufactured was a set of crayons carrying the systematic color designations of his system. Early on, Munsell sold his crayon business to Binney & Smith, the company that now manufactures Crayola crayons.

Had the sale gone another way, American children might now learn a very systematic and technically accurate way to describe color from their cray-

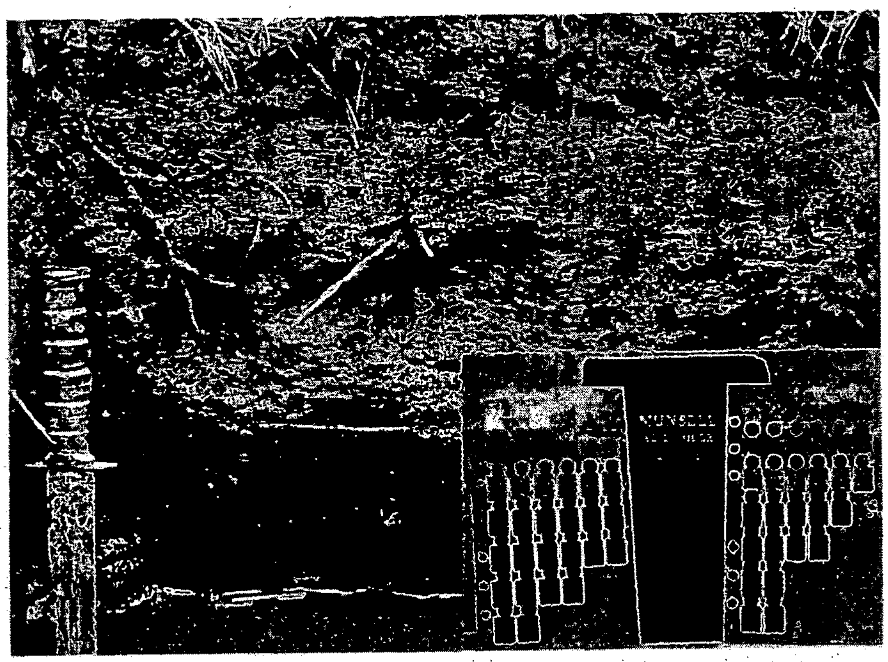


Figure 8. Munsell Soil Color Charts let soil scientists visually analyze samples in the field. In this view of a site in Maryland, the matrix of the water-saturated lower layer is black (designated 2.5Y 2.5/1 for hue value/chroma) due to the presence of the mineral pyrite, and the areated zone above has pale yellow streaks (5Y 7/4) of jarosite, a pyrite-oxidation product. (Photographs courtesy of the authors, Martin C. Rabenhorst of the University of Maryland, College Park and Ted Callender, U.S. Geological Survey-retired.)

ons. In some countries, such as Sweden, where the Swedish Natural Color System (NCS) is a national standard, children are taught a systematic method of color specification at an early age, and commerce (such as buying paint in a hardware store) is carried out using precise numerical color specifications that are also intuitive to those so trained. In the United States, instead of asking their playmates to share the 4PB 3/10 crayon, American children are left to ask for the "cerulean" crayon and then to ask their parents "what's a cerulean?"

Despite this one near-miss for popularizing the the Munsell system, there are examples everywhere of products that have benefited from some form of color-measurement system. The brewing of beer has provided an application of instrumental color measurement for nearly a century (and probably visual color measurement for many centuries before that). The brewer Joseph Lovibond is credited with creating one of the first color-measurement instruments, the Lovibond Tintometer (a version of which is still available). The tintometer is an instrument in which a colored sample, such as some beer, is matched with a mixture of cyan, magenta and yellow filters. The amounts of these standard tintometer filters required to make a match served as a color measurement. Nowadays, tintometer values and CIE color specifications can be computationally interconverted without the need for a visual assessment.

A recent example of use of the Munsell system for visual colorimetry can be found in the work on the spectrophotometric and colorimetric analysis and reproduction of rare works of art and other cultural heritage by Roy S. Berns of the Rochester Institute of Technology. Berns performed visual matching of painted areas in Georges Seurat's *A Sunday on La Grande Jatte—1884* at the Art Institute of Chicago, and the Star-Spangled Banner in the Smithsonian's National Museum of American History—the flag that inspired Francis Scott Key to write the poem that eventually became the American national anthem. Given the value of these two pieces, it is not feasible to make repeated instrumental measurements in contact with their surface or to illuminate them with the light intensities required for non-contact measurements. Samples from a modern *Munsell Book of Color* were used to quantify visually the current colors in both pieces and to check the few instrumental measurements that were allowed. The resulting color specifications were used to analyze the pigments in the Seurat painting and create a digital image representing the appearance of those colors when the painting was originally made. For the Star-Spangled Banner, which is now being stabilized for exhibition with a polyester backing, the measurements were used to help the Smithsonian design a new exhibit for the flag by simulating what it would look like after cleaning and with illumination by various types of light sources.

In the early part of the 21st century, the film industry is undergoing a transition to digital cinema. The century-old Munsell system is playing a role in this technological transition as well. Digital cinema projectors are capable of displaying an enormous range of colors, higher in chroma than those traditionally available in film and television systems. In utilizing these displays with existing content, it becomes necessary to map the colors available from historical displays to the extensive gamut of newer displays. One of the objectives in performing these mappings is to preserve the apparent hue of the colors in the images. The Munsell hue scales, as well as newer data on hue perception, have been used to derive mathematical color spaces that are now implemented in digital cinema systems. These color spaces have applicability to gamut mapping, the process of changing desired aim colors to colors within the capabilities of a display device while preserving the appearance of the images.

Color description using Munsell terminology is an important part of soil-profile characterization and soil mapping, providing field-discernable evidence of soil-forming processes. For example, color changes can indicate oxidation and reduction of iron compounds. When a high water table limits oxygen penetration into a soil that has developed on parent material that contains the ferrous iron mineral pyrite (FeS_2; typically black), that mineral is stable and tends to color the soil in the lower, water-saturated horizons. When pyrite reacts with atmospheric oxygen, sulfuric acid is produced, along with the pale yellow, ferric iron mineral jarosite [$KFe_3(SO_4)_2(OH)_6$]. As a result of this "sulfuricization" process, one sees both low soil *p*H and streaks of jarosite in the oxidizing zone above the water table. The presence of the distinctly colored jarosite is readily described using the *Munsell Soil Color Charts*. Other forms of oxidized iron such as the red, ferric oxide mineral hematite (Fe_2O_3) and the yellow-brown, ferric oxyhydroxide mineral goethite (FeOOH) can contribute to color features. Jarosite, hematite and goethite, either synthesized or mined from natural deposits, are used as paint pigments.

Color is fascinating to almost everyone, and the scientific study of color measurement and perception has a rich and interesting history. As with all fields, many have contributed, and modern scientists can see further by standing on the shoulders of the giants that preceded them. Color science is perhaps unique in the degree to which experts in a wide range of disciplines can make important contributions. Albert Munsell is one such example in which an artist and teacher satisfied his curiosity and need to teach by developing a system that had a profound impact on color science and commerce and will continue to do so long into the future.

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Attachment 2

United States
Environmental Protection
Agency

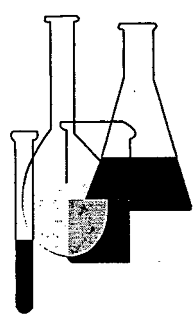
Prevention, Pesticides
and Toxic Substances
(7101)

EPA 712–C–96–019
August 1996

EPA

Product Properties Test Guidelines

OPPTS 830.6302 Color



INTRODUCTION

This guideline is one of a series of test guidelines that have been developed by the Office of Prevention, Pesticides and Toxic Substances, United States Environmental Protection Agency for use in the testing of pesticides and toxic substances, and the development of test data that must be submitted to the Agency for review under Federal regulations.

The Office of Prevention, Pesticides and Toxic Substances (OPPTS) has developed this guideline through a process of harmonization that blended the testing guidance and requirements that existed in the Office of Pollution Prevention and Toxics (OPPT) and appeared in Title 40, Chapter I, Subchapter R of the Code of Federal Regulations (CFR), the Office of Pesticide Programs (OPP) which appeared in publications of the National Technical Information Service (NTIS) and the guidelines published by the Organization for Economic Cooperation and Development (OECD).

The purpose of harmonizing these guidelines into a single set of OPPTS guidelines is to minimize variations among the testing procedures that must be performed to meet the data requirements of the U. S. Environmental Protection Agency under the Toxic Substances Control Act (15 U.S.C. 2601) and the Federal Insecticide, Fungicide and Rodenticide Act (7 U.S.C. 136, *et seq.*).

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OPPTS 830.6302 Color.

(a) **Scope**—(1) **Applicability.** This guideline is intended to meet testing requirements of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) (7 U.S.C. 136, *et seq.*).

(2) **Background.** The source material used in developing this harmonized OPPTS test guideline is OPP guideline 63–2 Color (Pesticide Assessment Guidelines, Subdivision D: Product Chemistry, EPA Report 540/9–82–018, October 1982) and 40 CFR 158.190 Physical and chemical characteristics.

(b) **Test method**—(1) **Objective.** Data on the physical and chemical characteristics of pesticide active ingredients and products are used to confirm or provide supportive information on their identity. Such data are also used in reviewing the production or formulating process used to produce the pesticide or product. Color, physical state, and odor are needed for the Agency to respond to emergency requests for identification of unlabeled pesticides involved in accidents or spills. Physicians, hospitals, and poison control centers also request this information to aid in their identification of materials implicated in poisoning episodes.

(2) **Test details.** (i) A visual description of the color (or lack of color) of each opaque substance may be reported qualitatively.

(ii) The Munsell color system described in ASTM "Standard Method of Specifying Color by the Munsell System, D-1535" may be used (see paragraph (d)(1) of this guideline). This system is based on the color-perception attributes hue, lightness, and chroma and offers a systematic visual method for solids (opaque substances) viewed in daylight by an observer with normal color vision.

(A) Test procedure. Using the Munsell Book of Color and special Gray Masks (supplied by the manufacturer) and daylight illuminating equipment, the observer visually compares the test sample to Munsell chips or charts to estimate from numbers assigned to the chips/charts, in the following order, the Munsell value, the chroma, and the hue. The chips or charts are then rearranged and the estimation is repeated and the values of the two trials are averaged. By use of special tables, a notation is developed which reports the determined Munsell hue, value, and chroma. Detailed procedures and explanations of the tables are presented in ASTM D-1535.

(B) [Reserved]

(iii) The Gardner Color scale described in ASTM D–1544, "Standard Test Method for Color of Transparent Liquids (Gardner Color Scale)" may also be used (see paragraph (d)(2) of this guideline). The method is based on the comparison of samples of the test substance against color reference standards.

(A) Test procedure. Glass tubes (such as viscosity tubes) are filled with the test substance and compared with similar tubes containing reference solutions corresponding to the Gardner Color Standard Number. The tubes are viewed under defined conditions for illumination source, surrounding field, and field of view described in the ASTM method. The method has 18 standard color solutions and provision is made for more precise measurements by interpolation between the standard values.

(B) [Reserved]

(iv) If an alternative method is used, it is recommended that the registrant consult with the Agency prior to adopting the test method.

(c) **Reporting.** (1) Qualitative terms, such as those listed in the "Handbook of Chemistry and Physics," may be used; or color may be reported by the Munsell or Gardnel color systems (see paragraphs (d)(3) and (d)(4) of this guideline).

(2) Any methods used to characterize the physical properties of a pesticide shall be referenced or described in the application for registration. If the methods used are listed in paragraph (d) of this guideline, reference to the method will suffice. If other methods are used, copies of such methods must be submitted with the application.

(3) References that denote "ASTM" refer to standardized methods published by the American Society for Testing and Materials, Philadelphia, PA.

(4) The applicant shall submit his own statistical evaluation of the precision and accuracy of these measurements (e.g., standard deviations or confidence intervals) when appropriate.

(d) **References.** The following references should be consulted for additional background material on this test guideline.

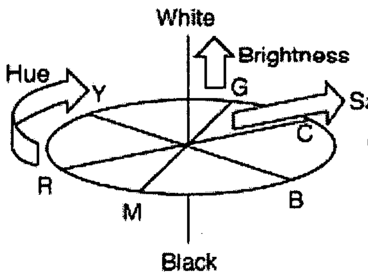
(1) American Society for Testing and Materials, "Standard Method of Specifying Color by the Munsell System, D-1535," ASTM, Philadelphia, PA, 1994 annual index.

(2) American Society for Testing and Materials, "Standard Test Method for Color of Transparent Liquids (Gardner Color Scale), D–1544," ASTM, Philadelphia, PA, 1994 annual index.

(3) *Handbook of Chemistry and Physics,* CRC Publishing Co., Boca Raton, FL, latest edition.

(4) Information on the Munsell color system may be obtained from Munsell Color, MacBeth Color and Photometry (division of Kollmorgen Corp.), 2441 N. Calvert St., Baltimore, MD 21218.

Attachment 3



MUNSELL COLOR SYSTEM

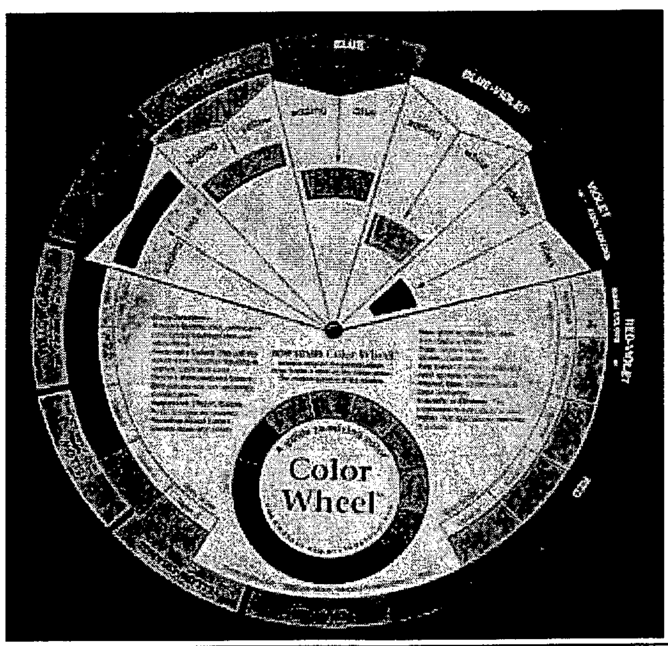
Characterizes colors by:
Hue: 100 equally spaced hues around circle

Saturation: units of "chroma" starting at 0 on the center line and increasing to values of 10 to 18 depending upon the hue. Some hues have more distinguishable levels of saturation.

Brightness: value from 0 for black to 10 for white.

The Munsell and Ostwald color systems match colors to a set of standard samples. The Munsell system divides hue into 100 equal divisions around a color circle. This is similar in approach to the Newton Color Circle except that the circle is distorted by assigning a unit of radial distance to each perceptable difference in saturation (called units of chroma). Since there are more perceptable differences for some hues, the figure will bulge outward to 18 values for some hues compared to only 10 for another. Perpendicular to the plane formed by hue and saturation is the brightness scale divided into a scale of "value" from 0 (black) to 10 (white). A point in the color space so defined is specified by hue, value, and chroma in the form H V/C.

The MUNSELL system is a collection of color samples for comparison, with adjacent samples based upon equal perceived differences in color.



Some features of the Munsell system are used in commercially available paint and pigment mixing guides like the Color Wheel.

Newton color circle | Comparison of Munsell and Ostwald systems

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Color vision

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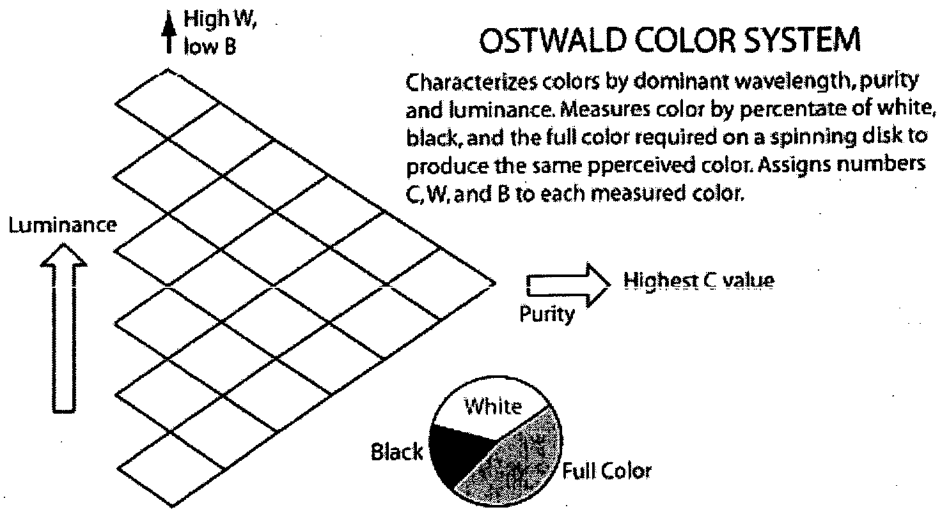

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Vision concepts

Color vision

Color measurement

The Ostwald and Munsell color systems match colors to a set of standard samples. The Ostwald system creates a color space based on dominant wavelength, purity, and luminance, mapping the values of hue, saturation and brightness. Establishing the values for these parameters is done with a disc colorimeter whch mixes on a disk amounts of the pure spectral color at the dominant wavelength with white, and black . Thus the point in the Ostwald color space is represented by values C,W, and B to represent the percentages of the circle. For example 35,15,50 represents 35% full color, 15% white, and 50% black.

The OSTWALD system is based upon an analysis of reflectance curves.

Comparison of Munsell and Ostwald systems

HyperPhysics***** Light and Vision

R Nave

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Vision concepts

Color vision

Comparison of Munsell & Ostwald

Munsell

Ostwald

The simplest and most widely used subjective color system

hue
chroma
value

Parameters of color space which map hue, saturation, and brightness.

dominant wavelength
purity
luminance

Complementary colors are not on opposite side of value axis.

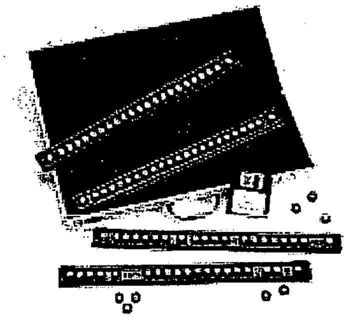
Problems with both

Based on subjective color comparisons.
Standard samples can fade and degrade system.

Munsell system	Ostwald system

Attachment 4

FM 100 Hue Test



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This test gives you an easy-to-administer but highly effective method for measuring any individual's color vision. Used by the government and industry for over 40 years, the test consists of four trays containing a total of 85 removable color reference caps (incremental hue variation) spanning the visible spectrum. Color vision abnormalities and aptitude are detected by the ability of the test subject to place the color caps in order of hue. We also include Windows®-based PC scoring software. The four trays are boxed in a handsome carrying case. The test must be administered under daylight conditions such as that provided by GretagMacbeth SpectraLight® and Judge viewing booths or the Sol-Source desk lamp.

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THE FARNSWORTH-MUNSELL 100-HUE TEST

for the examination of Color Discrimination

MANUAL

by Dean Farnsworth

Revised 1957

Copyright 1949, 1957

MUNSELL COLOR
MACBETH, DIVISION OF KOLLMORGEN INSTRUMENTS CORP.
405 Little Britain Road • New Windsor, New York 12553

THE FARNSWORTH-MUNSELL 100-HUE TEST

for the examination of Color Discrimination

INTRODUCTION

PURPOSE

The Farnsworth-Munsell 100-Hue Test offers a simple method for testing color discrimination. It yields data which can be applied to many psychological and industrial problems in color vision. Its primary uses are, first, to separate persons with normal color vision into classes of superior, average and low color discrimination, and second, to measure the zones of color confusion of color defective persons. A few examples will suggest the variety of special purposes for which it has been used:

Examination of inspectors of color goods, of colorgraders, of dye and paint mixers.

Testing for type and degree of color defectiveness.

Detection of poor color vision in salesmen.

Selection of applicants for vocational training.

Design of specialized tests for color vision.

Measurement of effects of medical treatments.

Independent control on validity of other color vision tests.

There are two purposes for which the 100-Hue Test was *not* designed: (a) it was not intended to distinguish fine degrees of differences between persons of superior aptitude, and (b) it was not intended to dichotomize color deficiency into "pass-and-fail" classes. With respect to (a): the 1978 Color Matching Aptitude Test was developed by a committee of the Inter-Society Color Council † to grade superior aptitude into degrees of excellence. With respect to (b): the "Dichotomous Test for Color Blindness" is recommended for the detection of persons who are functionally color defective, and the detection of employees who cannot surely distinguish colored products of ordinary industrial usage.*

Since this test is designed to measure a particular psychological aptitude it must not be expected that the scores will correlate directly with other tests for color vision. Pseudo-isochromatic plates, color vision lanterns, anomaloscopes and colorimeters isolate certain factors of color deficiency but do not measure general color discrimination directly as does the 100-Hue Test.

† *Test available from Federation of Societies for Coatings Technology, 1315 Walnut St., Suite 830, Philadelphia, Pennsylvania 19107.*

* *Test available from The Psychological Corporation, 757 Third Ave., New York, New York 10017.*

MATERIALS

The materials include four wooden cases, a total of ninety-three plastic caps in which the colors are mounted, and the score sheets. Each case consists of two hinged panels which enclose one-fourth of eighty-five numbered, removable color caps. (Two caps are repeated and fixed as pilot colors at either end of one panel in each case, making a total of ninety-three caps.) The scoring sheets contain four rows of numbers corresponding to the numbers on the backs of the removable color caps in the four cases, a scoring diagram, and spaces for recording other customary data.

Pigments in the color caps are made from the most stable materials available, but no chemical is absolutely permanent, and the caps should not, therefore, be unduly exposed to light. The matt surface of the painted papers is necessary in order to give the same spectral characteristics from any angle, but it is sensitive to fingerprints. It has been found that slight soiling has no effect upon the diagnostic value of the test; however, if the caps become severely smudged or damaged, they may be replaced individually or as a complete set. Additional score sheets, in pads of 100, are also available.

ADMINISTRATION

LIGHTING

Reliable results cannot be expected from this test unless standard illumination is used. The illumination should approximate 6,740° Kelvin (Illuminant "C" or average daylight) preferably at 25 foot candles or more. Such illumination is provided by daylight lamps of the type manufactured by the Macbeth Corporation.*

If natural daylight is used, the test should be given near a window illuminated chiefly from the north sky, lightly to moderately overcast. 6,500° *Daylight* Fluorescents may be used if necessary, but both natural daylight and fluorescent lighting are variable, and results cannot be expected to be as stable as when the test is given under standard illumination. Ordinary incandescent room lights should be switched off or shielded from the test area.

The most convenient position for the administrator of the test is across the table from the examinee. The light should be from above so that the angle of illumination is about 90° and the angle of viewing about 60°.

**Macbeth, Division of Kollmorgen Instruments Corp., 405 Little Britain Road, New Windsor, New York 12553.*

PROCEDURE

1. Open one case lengthwise before the examinee so that the empty, inclined panel to which the pilot caps are fixed is nearer the subject. The cases may be given in any order. Before being presented to the subject, the caps have been arranged in random order (see step No. 5).

2. Instruct the subject as follows:

> "The object of the test is to *arrange the caps in order according to color.* Please transfer them from this panel (indicate) to this panel (indicate) and place them so they form a regular color series between these two caps (indicate). It should take you about two minutes per panel. However, accuracy is more important than speed—so you will be told when the two minutes are up but the panel will not be taken away from you. Arrange them as best you can, but don't dawdle. Do you understand? Begin."

If the subject does not show comprehension, say,

> "Take the button which looks most like that (indicate a pilot button) and place it there . . . and the button most like that (indicate the last one) and place it there, and so on."

TIME

3. Allow subject as long as necessary for him to arrange the buttons in an order with which he is happy. If two minutes have passed and he isn't through, quietly remind him that two minutes are up, and let him finish his task.

For each panel, record the time spent on it and whether it was the first panel, second, etc., given. This information might be useful in interpreting results.

RECORDING DATA

4. Space is allowed on each data sheet for recording two trials, a test and retest. Where the numbers are found to be in correct order, draw a line above (on retest, below) the printed numbers. When they are not in serial order, record them in the order in which they are arranged by the examinee. An example is given at the bottom of Figure 1. Time will be saved if this and the following step are performed while the examinee is arranging the next panel.

5. After the arrangement of the caps has been recorded, transfer them to the opposite panel, rearranging them in random order. Then close the case and turn it over. It is now ready for future testing.

The transfer of caps should be made as recommended above because the backs of the caps are then uppermost and there is no danger of soiling the colors; also because the recessed design of the caps was selected to facilitate handling from this side.

SCORING AND DRAWING THE PATTERN

If but a few transpositions are made, the errors can be counted at once. It is not even necessary to draw the pattern. Count 4 for each 2-cap transposition and 8 for each 3-cap transposition.

If there are many errors it will be necessary to draw a pattern consisting of the scores for each cap. *The score for a cap is the sum of the differences between the number of that cap and the numbers of the caps adjacent to it.*

For example, note the scores of the following series of caps:

Recorded order of arrangement	5	6	7	8	13	11	9	10
Score for cap above		2	2	6	7	4	3	
How derived (sum of differences of adjacent numbers)		(1+1)	(1+1)	(1+5)	(5+2)	(2+2)	(2+1)	

The line of numbers on the score sheet is printed only for the administrator's convenience when there are few or no errors. In scoring an irregular series, *remember that only the examinee's order is concerned in the scoring and that it bears no relation to the printed numbers.*

The inner circle of numbers on the chart corresponds to the number of the caps. Take the first (inside) dotted line as a score of 2 (the lowest possible); the heavy dotted circles will be at 5 and at 10. *Mark the score for each cap on the radial line carrying its number.* Connect the points by lines of different colors for each test. An average can be found graphically by connecting points intermediate between the points on each radial line for each test.

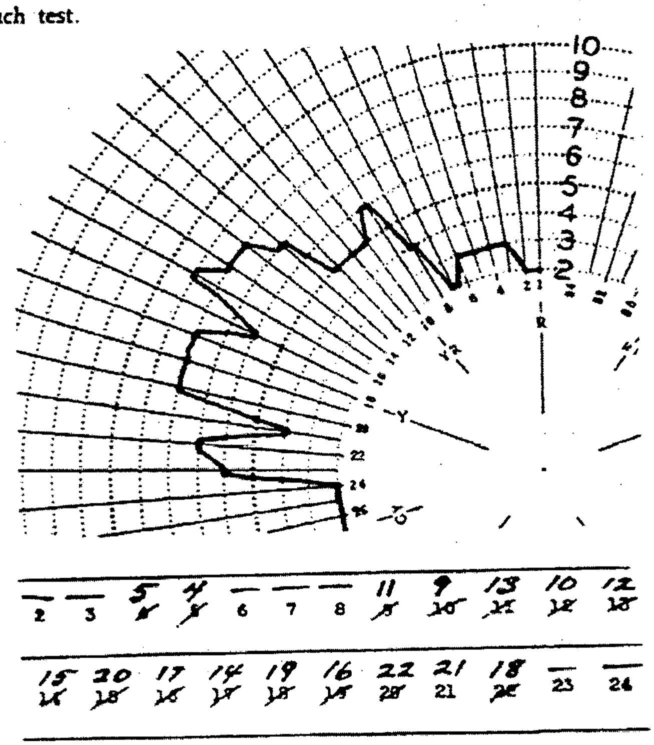

Fig. 1. Section of a subject's profile illustrating how error scores are plotted.

The total error score is obtained by summing the errors on each radial line, now counting the inner circle as zero. (This has the effect of subtracting 2 from each individual score so that perfect sequences appear as zero on the pattern and count as zero on the total error score.)

For example, in Figure 1 the error scores, reading clockwise, are: 0, 0, 0, 4, 5, 2, 6, 6, 6, 4, 7, 6, 6, 5, 3, 3, 3, 4, 2, 0, 1, 1, 1, 1, 0, 0. The total error score is 76. The mid-point of this error series would be 76÷2, or 38, which falls nearest cap 16.

RETESTS

The number of retests required is entirely dependent upon the degree of exactness desired. If it is merely necessary to ascertain that an examinee has no gross color deficiency, and one test shows that, there is no point in testing him again. The position of an individual in a population with regard to aptitude is usually determined by one retest. In general, it may be stated that retests should be given when the subject is inexperienced in handling test materials or when a more precise diagnosis is needed or when the pattern is in any way unclear or atypical.

INTERPRETATION

After the pattern has been plotted, there are various methods of interpreting the results, depending upon the information wanted from the test. Norms are given below for several common groups: superior discrimination, average and low discrimination, and for types of color defectiveness ("color blindness").

Sample distributions which have been found for certain populations are given on Page 6.

AVERAGE DISCRIMINATION

A typical test and retest pattern for an average normal is illustrated in Figure 2. Seven 2-cap transpositions were made on the first test, four 2-cap and one 3-cap transpositions on the retest, resulting in total error scores of 28 and 24 respectively.

About 68% of the population (exclusive of color defectives) make a total error score of between 20 and 100 on first tests. This may be taken as the range of normal competence for color discrimination.

SUPERIOR DISCRIMINATION

About 16% of the population (exclusive of color defectives) has been found to make 0 to 4 transpositions on first test, or total error scores of zero to 16. This may be taken as the range of superior competence for color discrimination.

LOW DISCRIMINATION

About 16% of the population (exclusive of color defectives) has been found to make total error scores of more than 100. The first retest may show improvement but further retests do not materially affect the score. Repeated retests reveal no region of large maximum or minimum sensitivity as is found in color defective patterns. An example of a low discrimination pattern is given in Figure 3.

Error scores by normals often exceed that of many color defectives, yet these individuals do not exhibit color blind indications on this test, on anomaloscopes, or on pseudo-isochromatic tests. Such scores point up the fact that the 100-Hue Test is, as described, a test of color aptitude or ability to make color discriminations. General color discrimination is independent of color defectiveness so it is possible for some normals to have poorer color discrimination than some color defectives. Color normals may have good or poor color discrimination; color defectives may have good or poor color discrimination.

DEFECTIVE COLOR VISION

The pattern of color defectiveness is identified by bi-polarity, a clustering of maximum errors in two regions which are nearly opposite. The regions in which the errors are made can be used to identify the type of color defectiveness if this is also of interest. Typical examples of patterns made by types of color-defective persons are shown in Figures 4, 5 and 6. Each of these cases exhibits a severe degree of defect; moderate cases show small "bulges" and lower total error scores; mild cases with good color discrimination may show no "bulge" and cannot be identified by this test. The position of the mid-points of the errors in the pattern (the middle of the "bulges") will identify the type. (The mid-points can be found roughly by inspection or accurately by the method described on page 3.)

The mid-points for indicating type of defect are best differentiated on the right-hand side of the pattern.

PROTANS (so-called red blind: protanopes and protanomalous) have a mid-point between 62 and 70. See Figures 4 and 7.

DEUTANS (so-called green blind: deuteranopes and deuteranomalous) have a mid-point between 56 and 61. See Figures 5 and 7.

TRITANS (so-called blue blind: tritanopes and tritanomalous) have a mid-point between 46 and 52. See Figures 6 and 7.

The distribution of mid-points from 112 tests are plotted in Figure 7. It shows the scatter to be expected from single test scores. Diagnosis of color defect should be made upon the average of at least two tests. The average of the mid-points of several tests will always fall within the ranges stated above. Some mildly defective individuals will be found whose discrimination or aptitude is so high that no amount of retesting will elicit a color-defective pattern.

The significance of a pattern can be described by reference to Figure 5. The errors lie chiefly between blue and purple-bluepurple, and between yellow-red and yellow-green-yellow. Research has shown that any series of colors parallel to the above series will also be confused. For instance, there will be low aptitude for discriminating red-purple, green and gray (in the middle of the diagram), low aptitude for discriminating purple from greenish-blue, or red from yellowish-green. On the other hand, the ability to distinguish colors in a green-yellow to blue series or to distinguish yellows from grays will be as good as that of most normals (because these series lie in lines which are parallel to the series in which he makes few or no errors).

As the terms "color defectiveness" and "color blindness" have been employed in literature, they indicate a type of systematic color *imbalance*, that is to say, certain series of colors are less well discriminated than other series of colors. Pseudo-isochromatic tests are designed to test color imbalance, but not to test color discrimination. The 100-hue pattern will indicate the type of the imbalance, the color zones of best and poorest perception and the degree of color discrimination in those zones as compared to normals.

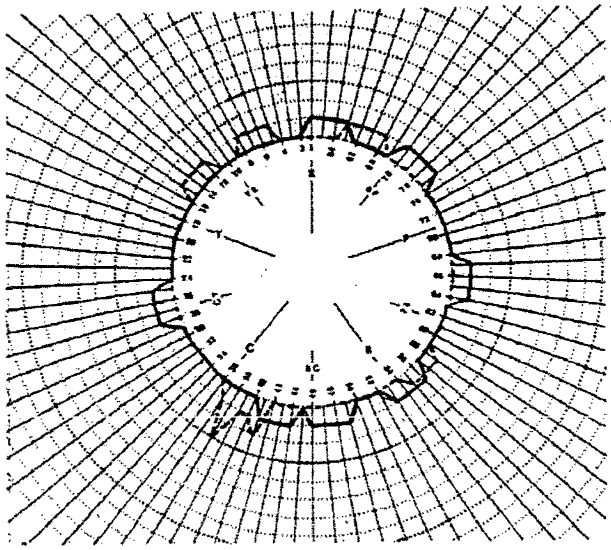

Fig. 2. Specimens of normal, average, discrimination patterns, 2 trials.

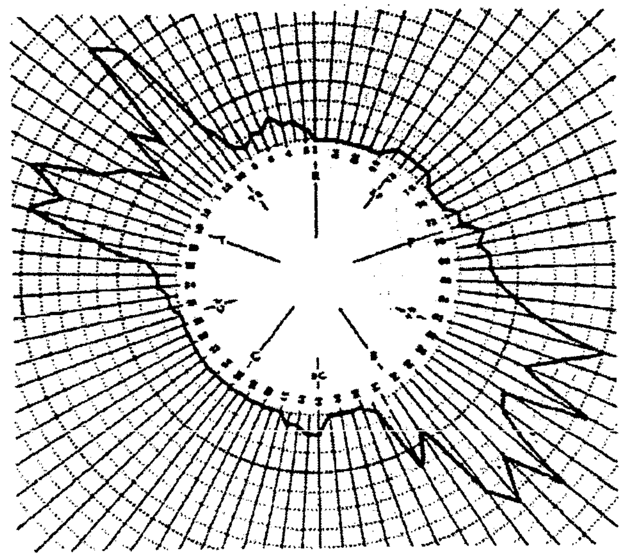

Fig. 5. Specimen of color defective pattern; Deutan. Average of 2 trials.

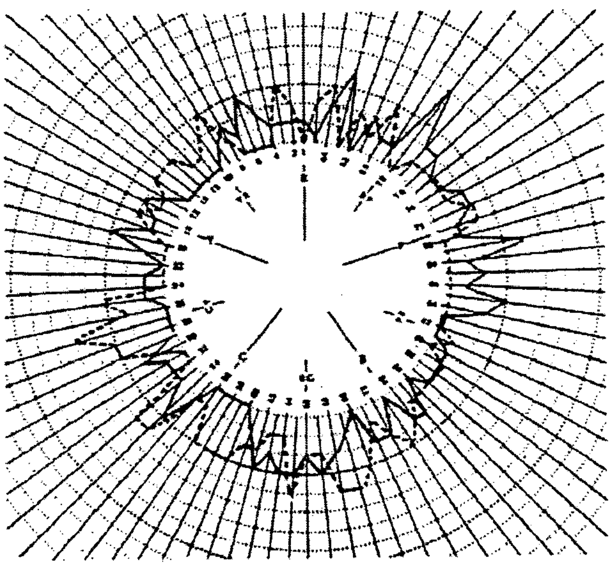

Fig. 3. Specimens of normal, low discrimination pattern, 2 trials.

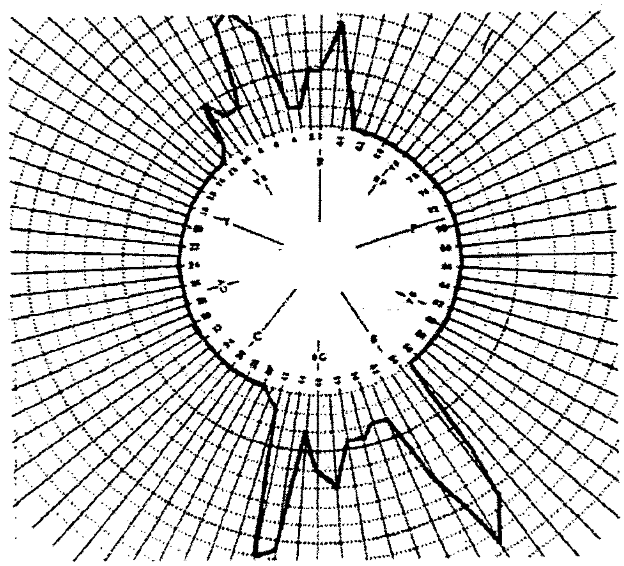

Fig. 6. Specimen of color defective pattern; Tritan. Average of 2 trials.

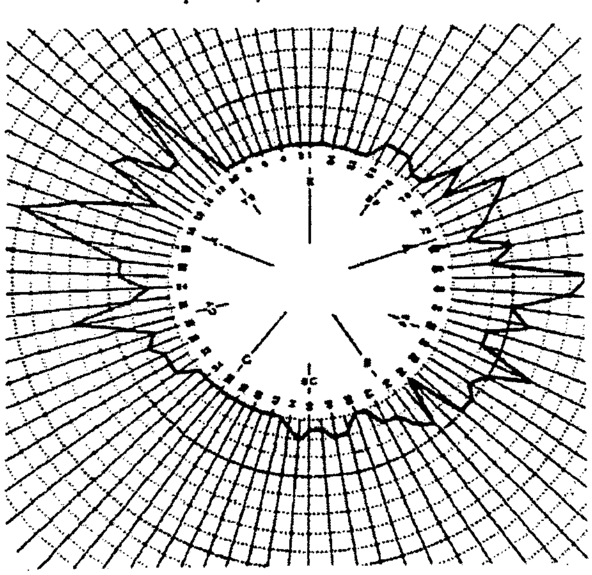

Fig. 4. Specimen of color defective pattern; Protan. Average of 2 trials.

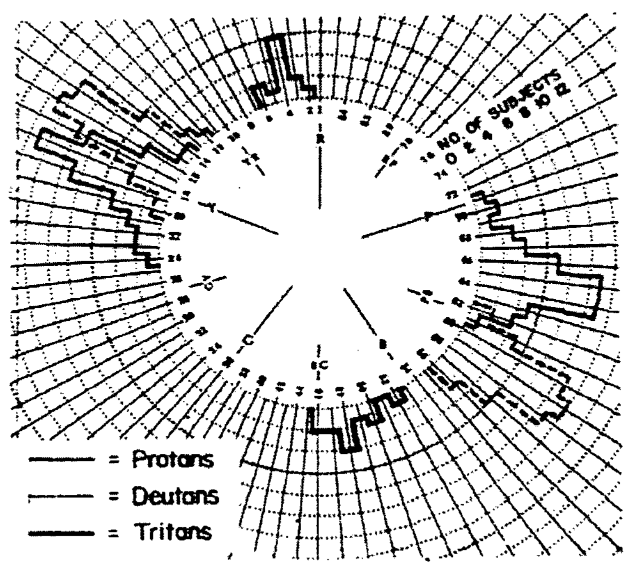

Fig. 7. Distribution of mid-points from 112 tests on color defective subjects: 50 protans, 50 deutans and 12 tritans.

INDUSTRIAL NORMS

The distribution of initial error scores which may be anticipated from particular populations is indicated in the following table. The "unselected" column shows the errors which may be expected from each percentile of an unselected group of people aged 15 to 45. The next column, "in-plant applicants," was drawn from 300 tests of employed personnel making application for promotion to positions of color control in a paint manufacturing plant—shader trainees, laboratory testers and laboratory technicians. The last column is accumulated from tests on 150 personnel of three to twenty years experience in the color control laboratories of manufacturers of dyes, rugs, plastics, textiles and paints. They are designated as "shaders," "matchers," "mixers," "inspectors," "passers," "dyers," and "titration testers."

Table 1. Distribution of Total Error Scores by Percentiles: First Tests

Percentage of group	Expected to make total error scores of, or less than		
	Unselected	in-plant applicants	Experienced
90 pc, upper 10%	12	4	0
80 pc, " 20%	20	8 - 12	0
70 pc, " 30%	28	16	4
60 pc. " 40%	36	20	4 - 8
50 pc, " 50%	46	24	8
40 pc, " 60%	60	28	12
30 pc " 70%	76	36	16
20 pc, " 80%	96	44	24
10 pc, " 90%	120	68	40

The test-retest reliabilities shown in Table 2 are taken from routine tests of applicants for promotion in a paint factory. In most cases the retests were taken within a few days of the first. It will be seen that there is an average reduction of 30 percent in total error scores between the first test and retest but little average improvement on the third test.

Table 2. Test-retest Reliability

	Test	Retest	2nd Retest
Test		.82	.67
Retest			.83
Mean	32.02	22.68	20.55
σ	29.02	23.08	23.44
N	196	196	137

These figures suggest that the second trial yields the more impotrant score. Some of the test-retest unreliability is doubtless due to variations in experience in handling this kind of material and would be eliminated by discarding the first score. However, if it is planned to use norms based on the second trial alone, the following conditions must be met: (1) every individual must certainly be given the second test, (2) the first test must be taken as seriously as the second, and not announced as practice, and (3) test and retest should be separated by a period of hours or days.

While total error scores may be taken as representative of the color discrimination of the individual at that period of his history, they do not indicate that his color discrimination ability may not improve at a later time as a result of further training and experience.

The author gratefully acknowledges the contributions of the many companies and laboratories who have supplied the above data, but especially that of Miss Helen Paulson, in charge of the Color Vision Section of the U. S. Naval Medical Research laboratory, and of the Fabrics and Finishes Department of E. I. duPont de Nemours & Company.

PRINCIPLE OF CONSTRUCTION

An understanding of the material in this section is not necessary for the practical use of this test. However, the information is important if the test is used in connection with research in color vision.

Let us imagine a chart made up of all possible discriminable hues—reds, greens, blues, etc., in all strengths from neutral to high purity, but all of the same brightness. If these colors were organized systematically, they would form a color array similar to that shown diagramatically in Figure 8. Equal distances on this diagram represents equal differences of color to the normal eye.

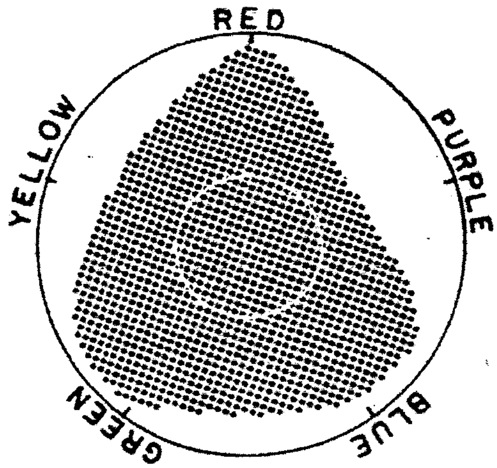

Fig. 8. Schematic representation of a uniform chromaticity scale diagram for normal vision. Neutral colors are in the middle, strong chromas at the edge.

Let us suppose that each dot represents a color which is just easily perceptably different from each adjacent color. We now have a unit of measurement which can be applied to color discrimination. It may be that in some regions of the chart, certain adjacent colors *cannot* be distinguished by a particular person or by a normal under some particular condition of viewing, and it may be necessary to skip three or five or ten color units before coming to a color which is just easily perceptably different from the first. If, for each particular purpose, or individual, it were possible to test each of the thousands of combinations on the diagram, a full description of color discrimination could be obtained for that condition or individual.

The principle or method of the F-M 100-Hue Test is to sample the color diagram in all *directions* and thereby indicate the degree and orientation of discrimination throughout the color field. Because changes in discrimination are systematic throughout the chromaticity plane generalized deductions can be made from the *sample* data furnished by the test.

By elimination and replacement in a series which originally consisted of one hundred Munsell colored papers,[1] a circuit of eighty-five papers was constructed, in which the hue differences were "just easily noticeable" by normals when the papers were suitably mounted. This mounting consists of plastic caps with black rims which separate the exposed part of the color discs by about their own diameter. It is also necessary that there be slight differences from disc to disc in value and chroma. The latter factor is the device which requires some expression of aptitude in normals, which detects color defectives by forcing them to resort to criteria of other than hue difference and, with the factor of black-rim separation, makes the test short enough for practical purposes. The positions of the 85 test colors are shown in Figure 9, plotted on the Farnsworth Uniform Chromaticity Scale Diagram #33. Their relation to the schematic array of colors is suggested by the white circle in Figure 8.

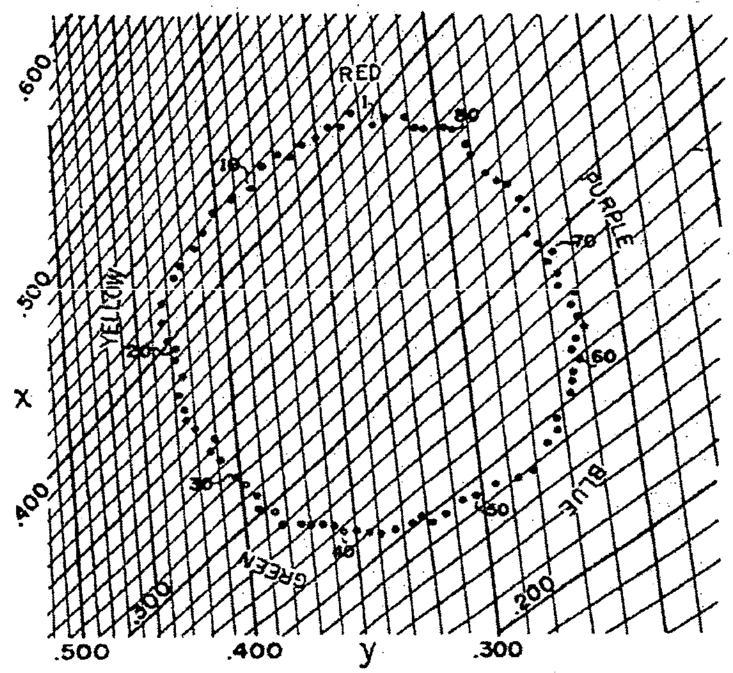

Fig. 9. Position of the test colors on a perspective projection (Farnsworth R.U.C.S. #33) of the C.I.E. Diagram.

The FM 100-Hue Test is recommended as an adjunct test for the analysis of color defectiveness. Examples of other specialized uses have been described by the author.[2] The same article describes the theory of its construction in somewhat more detail than is given in this instruction book. The organization of types and degrees of color defectiveness is briefly described in a pamphlet by the author obtainable from the Psychological Corporation.[3] The manner in which the test data can be related to the co-punctal loci is shown in a Medical Research Laboratory Research Report.[4]

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1. Dorothy Nickerson and Walter Granville, "Hue Sensibility to Dominant Wave-length Change," J. Opt. Soc. Am. *30,* 159 (1940).

2. Dean Farnsworth, "The Farnsworth-Munsell 100-Hue and Dichotomous Tests for Color Vision," J. Opt. Soc. Am., *33,* 568 (1943).

3. "The Farnsworth Dichotomous Test for Color Blindness, Panel D-15," The Psychological Corporation. 522 Fifth Ave., New York 36. N. Y.

4. Dean Farnsworth, "An Introduction to the Principles of Color Deficiency," Report No. 254, Medical Research Laboratory, 8 Sept. 1954.

Daniel R. Malone and H. Julia Hannay, "The Farnsworth-Munsell 100-Hue Test: A Question of Norms," *Auburn University. "Perceptual and Motor Skills,"* 1977, 44, 1249-1250.

Attachment 5

Standard Practice for Specifying Color by the Munsell System[1]

This standard is issued under the fixed designation D 1535; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice provides a means of specifying the colors of objects in terms of the Munsell color order system, a system based on the color-perception attributes hue, lightness, and chroma. The practice is limited to opaque objects, such as painted surfaces viewed in daylight by an observer having normal color vision. This practice provides a simple visual method as an alternative to the more precise and more complex method based on spectrophotometry and the CIE system (see Practices E 308 and E 1164). Provision is made for conversion of CIE data to Munsell notation.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 1729 Practice for Visual Appraisal of Colors and Color Differences of Diffusely-Illuminated Opaque Materials[2]

D 3134 Practice for Establishing Color and Gloss Tolerances[2]

E 284 Terminology of Appearance[2]

E 308 Practice for Computing the Colors of Objects by Using the CIE System[2]

E 1164 Practice for Obtaining Spectrophotometric Data for Object-Color Evaluation[2]

3. Terminology

3.1 Terms and definitions in Terminology E 284 are applicable to this practice.

3.2 *Definitions:*

3.2.1 *Munsell notation, n*—(*1*) the Munsell hue, value, and chroma assigned to the color of a specimen by visually comparing the specimen to the chips in the *Munsell Book of Color*;[3] (*2*) a notation in the Munsell color system, derived from luminous reflectance factor *Y* and chromaticity coordinates *x* and *y*, in the CIE system for standard illuminant *C*, by the use of scales defined by the Optical Society of America Subcommittee on the Spacing of the Munsell Colors (**1**).[4]

3.2.1.1 *Discussion*—The Munsell notation is written as a combination of letters and numbers by which the color of an opaque object may be specified with respect to Munsell hue *H*, Munsell value *V*, and Munsell chroma *C*, written in the form *H V/C*.

3.2.2 *hue, n*—the attribute of color perception by means of which a color is judged to be red, orange, yellow, green, blue, purple, or intermediate between adjacent pairs of these, considered in a closed ring (red and purple being an adjacent pair).

3.2.3 *Munsell hue, n*—an attribute of color used in the Munsell color system to indicate the hue of a specimen viewed in daylight.

3.2.3.1 *Discussion*—Two systems of designating Munsell hue are shown in Fig. 1, a letter-number system and an all-number system. The two systems are equivalent, but the letter-number system is preferred, because it requires no prior knowledge or memory of the correspondence of numbers to hues. The hue circle is graduated in steps judged visually to be approximately equal.

3.2.4 *lightness, n*—the attribute of color perception by which a non-self-luminous body is judged to reflect more or less light.

3.2.5 *Munsell value, n*—an attribute of color used in the Munsell color system to indicate the lightness of a specimen viewed in daylight, on a scale extending from 0 for ideal black to 10 for ideal white, in steps that are visually approximately equal in magnitude.

3.2.5.1 *Discussion*—Achromatic or neutral colors are designated *N* followed by the value notation, thus: *N* 5.61/.

3.2.6 *chroma, n*—the attribute of color used to indicate the degree of departure of the color from a neutral color of the same lightness.

3.2.7 *Munsell chroma, n*—an attribute of color used in the Munsell color system to indicate the degree of departure of a color from a gray of the same Munsell value, in steps that are visually approximately equal in magnitude.

3.3 *Definitions of Terms Specific to This Standard:*

3.3.1 *Munsell surface-color perception solid, n*—a spatial representation of colors in the form of a cylindrical coordinate

[1] This practice is under the jurisdiction of ASTM Committee E12 on Color and Appearance and is the direct responsibility of Subcommittee E12.07 on Color Order Systems.

Current edition approved June 10, 2001. Published August 2001. Originally published as D 1535 – 58 T. Last previous edition D 1535 – 97.

[2] *Annual Book of ASTM Standards*, Vol 06.01.

[3] Available from GretagMacbeth, 617 Little Britain Road, New Windsor, NY 12553-6148.

[4] The boldface numbers in parentheses refer to a list of references at the end of this standard.

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system based on the three perceptual attributes: hue, lightness and chroma.

3.3.1.1 *Discussion—(1)* This solid (see Fig. 2 **(2)**) forms the basis of the Munsell notation in which Munsell hue corresponds to hue, Munsell value corresponds to lightness, and Munsell chroma corresponds to chroma. The central, vertical axis dimension represents neutral colors, ranging from black at the bottom, through a gradation of grays, to white at the top. The lightness of a color perceived as chromatic (not gray) is represented by the distance above the base plane. Hue is represented by the angular position about this axis (see Discussion (2)). Chroma is represented by the perpendicular distance from the central axis. If the observer has normal color vision, is adapted to daylight, and views the specimen illuminated by CIE source *C* or *D*65, against a medium gray to white background, the Munsell value of the specimen correlates well with the observer's perception of the lightness of the color. Under the same conditions, the Munsell hue correlates well with the observer's perception of hue and the Munsell chroma with the perception of chroma.

3.3.1.2 *Discussion—(2)* Although the original system proposed by Munsell was a left-handed coordinate system, the system is often represented as a right-handed system because it facilitates comparison to the CIE chromaticity diagram, taken to be right-handed.

3.3.2 *Munsell hue circle, n*—a spatial representation of the Munsell hue sectors on a circle, where the angular spacing represents a uniform scaling of hue; see Fig. 2.

4. Significance and Use

4.1 This practice is used by artists, designers, scientists, engineers, and government regulators, to specify an existing or desired color. It is used in the natural sciences to record the colors of specimens, or identify specimens, such as human complexion, flowers, foliage, soils, and minerals. It is used to specify colors for commerce and for control of color-production processes, when instrumental color measurement is not economical. The Munsell system is widely used for color tolerancing, even when instrumentation is employed (see Practice D 3134). It is common practice to have color chips made to illustrate an aim color and the just tolerable deviations from that color in hue, value, and chroma, such a set of chips being called a *Color Tolerance Set*. A color tolerance set exhibits the aim color and color tolerances so that everyone involved in the selection, production, and acceptance of the color can directly perceive the intent of the specification, before bidding to supply the color or starting production. A color tolerance set may be measured to establish instrumental tolerances. Without extensive experience, it may be impossible to visualize the meaning of numbers resulting from color measurement, but by this practice, the numbers can be translated to the Munsell color-order system, which is exemplified by colored chips for visual examination. This color-order system is the basis of the ISCC-NBS Method of Designating Colors and a Dictionary of Color Names, as well as the Universal Color Language, which associates color names, in the English language, with Munsell notations **(3)**.

5. Apparatus

5.1 *Munsell Book of Color*, matte or glossy edition.[3]

5.2 *Gray Masks*, with rectangular openings the size of the chips in the *Munsell Book of Color*.

5.3 *Daylight Illuminating Equipment*, as described in Practice D 1729.

6. Preparation of Test Specimens

6.1 This practice does not cover the preparation of test specimens. If preparation is necessary, see other ASTM standards covering the appropriate materials or agree among interested parties on what the procedure shall be.

7. Munsell Notation by Visual Means

7.1 *Lighting and Viewing Conditions*:

7.1.1 Specimens must be examined by an observer with normal color vision.

7.1.2 For critical applications, use daylight illuminating equipment as described in Practice D 1729.

7.1.3 If the lighting equipment described in Practice D 1729 is not available, natural daylight can be used to obtain notations having accuracy adequate for many purposes.

7.2 *Procedure*:

7.2.1 When using daylight illuminating equipment, follow the lighting and viewing recommendations of Practice D 1729.

7.2.2 When determining the Munsell notation with natural daylight, select a window through which the sun is not shining. A north window is usually used in the northern hemisphere, and a south window is usually used in the southern hemisphere. Place a working surface at the window so the light reaches the surface from the observer's side, chiefly from the sky, and at angles centering on 45° above the horizontal. Place a canopy of black cloth above the working surface to prevent errors caused by the ceiling or other objects being reflected from the surface of the specimens, or by light other than daylight falling on the work surface. Place the specimen on a neutral medium gray to white background, where it is uniformly illuminated by daylight. View the specimen along a direction just far enough from the normal to avoid reflection of your forehead. Although 45° illumination and perpendicular viewing are recommended by the CIE, converse conditions are equivalent if a black matte surface is placed opposite the observer to minimize the amount of light reflected from the specimen surface.

7.2.3 If both matte and glossy editions of the *Munsell Book of Color* are available, use the one having gloss most like the specimen. Select the two adjacent Munsell constant-hue charts or chips between which the hue of the specimen lies. Place one on each side of the specimen. Cover the specimen and charts with the gray masks so the specimen and one chip from each chart can be seen. Move the masks from chip to chip to find the chips most like the specimen. The glossy chips are removable. Remove them and place immediately adjacent to the specimen. Estimate, in the following order, the value, the chroma, and the hue, by interpolation or extrapolation of the notations on the chips, as described in 7.2.3.1 to 7.2.3.3. Interchange the positions of the charts, repeat the estimations, and average the results.

7.2.3.1 *Value*—Find the chips between which the value of the specimen lies. Estimate the value of the specimen to the

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nearest tenth of the one-value-step interval between adjacent value levels and record it, for example, 4.2.

7.2.3.2 *Chroma*—Move the masks to present successive colors of the same chroma and, by interpolation or extrapolation, determine the Munsell chroma. Pay chief attention to the Munsell chips having values nearest that of the specimen and secondary attention to those next nearest. Although all Munsell chips of the same Munsell chroma are intended to appear to have the same perceptual chroma, a slightly different estimate of chroma may be obtained by comparison with the chips of the next value. In such cases, average the estimated Munsell chromas. Note that there are usually two chroma steps between adjacent columns of a chart. Estimate chroma to the nearest fifth of the 2-chroma interval and record it, for example, 6.4.

7.2.3.3 *Hue*—Estimate the hue of the specimen by interpolation between the chips of the nearest Munsell value and chroma in the selected hue charts. Estimate to the nearest fifth of the 2.5-hue steps between adjacent hue charts and record it, for example, 4.5 *R*. (The tenth step of one hue sector is the zero of the next. The 10 is used; the zero is not.) If the value and chroma of the specimen do not correspond closely to those of any chip, repeat the interpolation of hue with the next closest pair of chips and record the average or estimate the hue as being closer to that of one or the other of the selected pairs of chips.

7.2.3.4 The Munsell notation for the hue *H*, the value *V*, and the chroma *C*, is written in the form *HV/C*. Using the examples given, the Munsell notation would be written 4.5 *R* 4.2/6.4.

8. Munsell Color Notation from CIE Measurement

NOTE 1—The CIE results for the specimen must be based upon color measurements in which the specular component was excluded, and with calculations made using the 1931 2° standard observer and illuminant C.

8.1 *Procedure*—Convert the luminous reflectance, *Y*, and the chromaticity coordinates, *x, y*, of the specimen to Munsell color notation by use of Table 1 and Figs. 3-16.[5] Table 2 contains the numerical data from Ref **(1)** upon which Figs. 3-16 were based.

NOTE 2—For further information concerning Figs. 3-7, Fig. 9, Fig. 11, Fig. 13, Fig. 15 and Fig. 16 see Newhall, et al. **(1)**. For further information concerning Fig. 8 and Fig. 10, see I. Nimeroff **(2)**.

NOTE 3—The luminous reflectance in the original reference **(1)** was measured relative to Magnesium Oxide. The luminous reflectance values in Table 2 were changed so that it is relative to the perfect reflecting diffuser.

8.2 In Table 1, find the value, *V*, equivalent to the luminous reflectance, *Y*. Use Figs. 3-16 to estimate hue and chroma for value levels above and below the value found and linearly interpolate the hues and chromas for the desired value level. If the required value level differs from the nearest level by 0.05 or less, simply use the hue and chroma for the nearest level.

8.3 *Munsell Notation of Dark Colors*— If the Munsell value is less than 1.0, use the extension of the Munsell system to very dark colors **(4)**. Table 3 contains the numerical data from Ref **(4)** for 40 hues at values 0.8/, 0.6/, 0.4/, and 0.2/ and chromas up to the theoretical pigment limits.

NOTE 4—The luminous reflectance in the original reference **(4)** was measured relative to Magnesium Oxide. The luminous reflectance in Table 2 was changed so that it is relative to the perfect reflecting diffuser.

8.4 Table 1 was derived from the following relationships **(5)**:

$$\text{For } Y \leq 0.9\text{: } V = UY^{W} \tag{1}$$

$$\begin{aligned}\text{For } Y \geq 0.9\text{: } V = {} & AY^{1/3} - B - C/[(DY-E)^2 + F] \\ & + G/Y^{H} + J\sin(KY^{1/3}+1) \\ & + (M/Y)\sin[N(Y-2)] \\ & - (P/QY)\sin[S(Y-T)]\end{aligned}$$

where:
A = 2.49268
B = 1.5614
C = 0.985
D = 0.1073
E = 3.084
F = 7.54
G = 0.0133
H = 2.3
J = 0.0084
K = 4.1
M = 0.0221
N = 0.39
P = 0.0037
Q = 0.44
S = 1.28
T = 0.53
U = 0.87445
W = 0.9967

8.5 *Computer Conversion of CIE Measurement Data*—Computer programs that convert CIE data to Munsell color notations are available commercially from various manufacturers of color control instruments or software, or both. The accuracy of a computer program can be determined by comparing the results obtained with that program to those obtained using the graphical method described in this practice. Before using a computer conversion program, the user should ascertain that the program's accuracy is sufficient for the proposed usage. Table 4 contains graphical conversions that may be used to verify the accuracy of data obtained by computer conversions.

NOTE 5—Many of the original computer programs used Magnesium Oxide as the reference white for determining luminous reflectance, Y, and Munsell Value, V. The reference white was changed to the perfect reflecting diffuser, and the user should ascertain that the computer conversion program uses the correct reference white.

NOTE 6—Although the chromaticity coordinates were not affected by the change of the reference white to the perfect reflecting diffuser, CIE X and Z tristimulus values calculated from them will change. The changes in X, Y, and Z will also affect color coordinates determined by transforming those tristimulus values.

9. Report

9.1 Report the notation in the Munsell system, specifying whether the notation was obtained visually, using the matte or

[5] Figures 8, 10, 12, 14, and 16 are enlargements of the low-chroma areas of Figs. 7, 9, 11, 13, and 15. Large-scale diagrams of Figs. 3 through 16 are available from GretagMacbeth.

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glossy *Munsell Book of Color*, or by conversion of CIE colorimetric data.

9.1.1 If obtained visually, note the source of illumination (artificial daylight or natural daylight).

9.1.2 If obtained from colorimetric data, note the instrument used.

10. Precision

10.1 The estimated precision within which a color notation can be determined by visual interpolation is 0.5 hue step, 0.1 value step, and 0.4 chroma step.

11. Keywords

11.1 color; Munsell; Munsell color order system; Munsell notation

APPENDIX

(Nonmandatory Information)

X1. EXAMPLE OF CONVERTING OF MUNSELL NOTATION

X1.1 Given the CIE data $Y = 46.02$, $x = 0.500$ and $y = 0.454$, find the Munsell notation.

X1.1.1 In Table 1, $Y = 46.02$ corresponds to Munsell value 7.28.

X1.1.2 The value lies between 7 and 8, so the hue and chroma will be found by interpolating these quantities between those found in Fig. 11 and Fig. 13. On Fig. 11, $x = 0.500$ and $y = 0.454$ corresponds to a hue of 10*YR* and a chroma of 13.1. On Fig. 13, the same x and y correspond to a hue just a small amount redder than 10*YR*, an amount less than 0.25 hue step, so the hue is read as 10*YR*. The chroma is 14.6.

X1.1.3 The value is 7.28, which is 0.28 of the way from 7 to 8, so the interpolated hue is that for value 7 plus 0.28 times the difference between the hues found at those two value levels. Since the difference was zero, the interpolated hue is simply the hue found for value 7. The interpolated chroma is found in the same way. The difference in chroma for the two value levels is 14.6–13.1 = 1.5. The difference is multiplied by the interpolation factor: $1.5 \times 0.28 = 0.42$, which may be rounded to 0.4. This amount is added to the chroma for value level 7: $0.4 + 13.1 = 13.5$.

X1.1.4 The Munsell notation is 10*YR* 7.2/13.5.

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TABLE 1 Munsell Value *V* for Given Luminous Reflectance Factor *Y*, in Percent, Relative to the Perfect Reflecting Diffuser

Y	V	Y	V	Y	V	Y	V	Y	V
0.01	0.01	0.71	0.62	1.41	1.16	2.11	1.57	2.81	1.90
0.02	0.02	0.72	0.63	1.42	1.17	2.12	1.58	2.82	1.90
0.03	0.03	0.73	0.64	1.43	1.18	2.13	1.58	2.83	1.91
0.04	0.04	0.74	0.65	1.44	1.18	2.14	1.59	2.84	1.91
0.05	0.04	0.75	0.66	1.45	1.19	2.15	1.59	2.85	1.92
0.06	0.05	0.76	0.67	1.46	1.20	2.16	1.60	2.86	1.92
0.07	0.06	0.77	0.67	1.47	1.20	2.17	1.60	2.87	1.92
0.08	0.07	0.78	0.68	1.48	1.21	2.18	1.61	2.88	1.93
0.09	0.08	0.79	0.69	1.49	1.22	2.19	1.61	2.89	1.93
0.10	0.09	0.80	0.70	1.50	1.22	2.20	1.62	2.90	1.94
0.11	0.10	0.81	0.71	1.51	1.23	2.21	1.62	2.91	1.94
0.12	0.11	0.82	0.72	1.52	1.24	2.22	1.63	2.92	1.94
0.13	0.11	0.83	0.73	1.53	1.24	2.23	1.63	2.93	1.95
0.14	0.12	0.84	0.73	1.54	1.25	2.24	1.64	2.94	1.95
0.15	0.13	0.85	0.74	1.55	1.25	2.25	1.64	2.95	1.96
0.16	0.14	0.86	0.75	1.56	1.26	2.26	1.65	2.96	1.96
0.17	0.15	0.87	0.76	1.57	1.27	2.27	1.65	2.97	1.97
0.18	0.16	0.88	0.77	1.58	1.27	2.28	1.66	2.98	1.97
0.19	0.17	0.89	0.78	1.59	1.28	2.29	1.66	2.99	1.97
0.20	0.18	0.90	0.79	1.60	1.29	2.30	1.67	3.00	1.98
0.21	0.18	0.91	0.79	1.61	1.29	2.31	1.67	3.01	1.98
0.22	0.19	0.92	0.80	1.62	1.30	2.32	1.68	3.02	1.99
0.23	0.20	0.93	0.81	1.63	1.30	2.33	1.68	3.03	1.99
0.24	0.21	0.94	0.81	1.64	1.31	2.34	1.69	3.04	1.99
0.25	0.22	0.95	0.82	1.65	1.32	2.35	1.69	3.05	2.00
0.26	0.23	0.96	0.83	1.66	1.32	2.36	1.70	3.06	2.00
0.27	0.24	0.97	0.84	1.67	1.33	2.37	1.70	3.07	2.01
0.28	0.25	0.98	0.85	1.68	1.33	2.38	1.71	3.08	2.01
0.29	0.25	0.99	0.86	1.69	1.34	2.39	1.71	3.09	2.01
0.30	0.26	1.00	0.86	1.70	1.35	2.40	1.72	3.10	2.02
0.31	0.27	1.01	0.87	1.71	1.35	2.41	1.72	3.11	2.02
0.32	0.28	1.02	0.88	1.72	1.36	2.42	1.72	3.12	2.03
0.33	0.29	1.03	0.89	1.73	1.36	2.43	1.73	3.13	2.03
0.34	0.30	1.04	0.90	1.74	1.37	2.44	1.73	3.14	2.03
0.35	0.31	1.05	0.90	1.75	1.38	2.45	1.74	3.15	2.04
0.36	0.32	1.06	0.91	1.76	1.38	2.46	1.74	3.16	2.04
0.37	0.32	1.07	0.92	1.77	1.39	2.47	1.75	3.17	2.05
0.38	0.33	1.08	0.93	1.78	1.39	2.48	1.75	3.18	2.05
0.39	0.34	1.09	0.94	1.79	1.40	2.49	1.76	3.19	2.05
0.40	0.35	1.10	0.94	1.80	1.40	2.50	1.76	3.20	2.06
0.41	0.36	1.11	0.95	1.81	1.41	2.51	1.77	3.21	2.06
0.42	0.37	1.12	0.96	1.82	1.42	2.52	1.77	3.22	2.06
0.43	0.38	1.13	0.97	1.83	1.42	2.53	1.78	3.23	2.07
0.44	0.39	1.14	0.97	1.84	1.43	2.54	1.78	3.24	2.07
0.45	0.39	1.15	0.98	1.85	1.43	2.55	1.78	3.25	2.08
0.46	0.40	1.16	0.99	1.86	1.44	2.56	1.79	3.26	2.08
0.47	0.41	1.17	1.00	1.87	1.44	2.57	1.79	3.27	2.08
0.48	0.42	1.18	1.00	1.88	1.45	2.58	1.80	3.28	2.09
0.49	0.43	1.19	1.01	1.89	1.45	2.59	1.80	3.29	2.09
0.50	0.44	1.20	1.02	1.90	1.46	2.60	1.81	3.30	2.10
0.51	0.45	1.21	1.03	1.91	1.47	2.61	1.81	3.31	2.10
0.52	0.46	1.22	1.03	1.92	1.47	2.62	1.82	3.32	2.10
0.53	0.46	1.23	1.04	1.93	1.48	2.63	1.82	3.33	2.11
0.54	0.47	1.24	1.05	1.94	1.48	2.64	1.82	3.34	2.11
0.55	0.48	1.25	1.05	1.95	1.49	2.65	1.83	3.35	2.11
0.56	0.49	1.26	1.06	1.96	1.49	2.66	1.83	3.36	2.12
0.57	0.50	1.27	1.07	1.97	1.50	2.67	1.84	3.37	2.12
0.58	0.51	1.28	1.08	1.98	1.50	2.68	1.84	3.38	2.13
0.59	0.52	1.29	1.08	1.99	1.51	2.69	1.85	3.39	2.13
0.60	0.53	1.30	1.09	2.00	1.51	2.70	1.85	3.40	2.13
0.61	0.53	1.31	1.10	2.01	1.52	2.71	1.86	3.41	2.14
0.62	0.54	1.32	1.10	2.02	1.53	2.72	1.86	3.42	2.14
0.63	0.55	1.33	1.11	2.03	1.53	2.73	1.86	3.43	2.14
0.64	0.56	1.34	1.12	2.04	1.54	2.74	1.87	3.44	2.15
0.65	0.57	1.35	1.12	2.05	1.54	2.75	1.87	3.45	2.15
0.66	0.58	1.36	1.13	2.06	1.55	2.76	1.88	3.46	2.15
0.67	0.59	1.37	1.14	2.07	1.55	2.77	1.88	3.47	2.16
0.68	0.60	1.38	1.14	2.08	1.56	2.78	1.89	3.48	2.16
0.69	0.60	1.39	1.15	2.09	1.56	2.79	1.89	3.49	2.17
0.70	0.61	1.40	1.16	2.10	1.57	2.80	1.89	3.50	2.17

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TABLE 1 *Continued*

Y	V	Y	V	Y	V	Y	V	Y	V
3.51	2.17	4.21	2.41	4.91	2.62	5.61	2.81	6.31	2.98
3.52	2.18	4.22	2.41	4.92	2.62	5.62	2.81	6.32	2.98
3.53	2.18	4.23	2.42	4.93	2.62	5.63	2.81	6.33	2.98
3.54	2.18	4.24	2.42	4.94	2.63	5.64	2.81	6.34	2.99
3.55	2.19	4.25	2.42	4.95	2.63	5.65	2.82	6.35	2.99
3.56	2.19	4.26	2.43	4.96	2.63	5.66	2.82	6.36	2.99
3.57	2.19	4.27	2.43	4.97	2.64	5.67	2.82	6.37	2.99
3.58	2.20	4.28	2.43	4.98	2.64	5.68	2.83	6.38	3.00
3.59	2.20	4.29	2.44	4.99	2.64	5.69	2.83	6.39	3.00
3.60	2.21	4.30	2.44	5.00	2.64	5.70	2.83	6.40	3.00
3.61	2.21	4.31	2.44	5.01	2.65	5.71	2.83	6.41	3.00
3.62	2.21	4.32	2.44	5.02	2.65	5.72	2.84	6.42	3.01
3.63	2.22	4.33	2.45	5.03	2.65	5.73	2.84	6.43	3.01
3.64	2.22	4.34	2.45	5.04	2.66	5.74	2.84	6.44	3.01
3.65	2.22	4.35	2.45	5.05	2.66	5.75	2.84	6.45	3.01
3.66	2.23	4.36	2.46	5.06	2.66	5.76	2.85	6.46	3.01
3.67	2.23	4.37	2.46	5.07	2.66	5.77	2.85	6.47	3.02
3.68	2.23	4.38	2.46	5.08	2.67	5.78	2.85	6.48	3.02
3.69	2.24	4.39	2.47	5.09	2.67	5.79	2.85	6.49	3.02
3.70	2.24	4.40	2.47	5.10	2.67	5.80	2.86	6.50	3.02
3.71	2.24	4.41	2.47	5.11	2.67	5.81	2.86	6.51	3.03
3.72	2.25	4.42	2.48	5.12	2.68	5.82	2.86	6.52	3.03
3.73	2.25	4.43	2.48	5.13	2.68	5.83	2.86	6.53	3.03
3.74	2.25	4.44	2.48	5.14	2.68	5.84	2.87	6.54	3.03
3.75	2.26	4.45	2.48	5.15	2.69	5.85	2.87	6.55	3.04
3.76	2.26	4.46	2.49	5.16	2.69	5.86	2.87	6.56	3.04
3.77	2.26	4.47	2.49	5.17	2.69	5.87	2.87	6.57	3.04
3.78	2.27	4.48	2.49	5.18	2.69	5.88	2.88	6.58	3.04
3.79	2.27	4.49	2.50	5.19	2.70	5.89	2.88	6.59	3.05
3.80	2.28	4.50	2.50	5.20	2.70	5.90	2.88	6.60	3.05
3.81	2.28	4.51	2.50	5.21	2.70	5.91	2.88	6.61	3.05
3.82	2.28	4.52	2.51	5.22	2.70	5.92	2.89	6.62	3.05
3.83	2.29	4.53	2.51	5.23	2.71	5.93	2.89	6.63	3.05
3.84	2.29	4.54	2.51	5.24	2.71	5.94	2.89	6.64	3.06
3.85	2.29	4.55	2.51	5.25	2.71	5.95	2.89	6.65	3.06
3.86	2.30	4.56	2.52	5.26	2.72	5.96	2.90	6.66	3.06
3.87	2.30	4.57	2.52	5.27	2.72	5.97	2.90	6.67	3.06
3.88	2.30	4.58	2.52	5.28	2.72	5.98	2.90	6.68	3.07
3.89	2.31	4.59	2.53	5.29	2.72	5.99	2.90	6.69	3.07
3.90	2.31	4.60	2.53	5.30	2.73	6.00	2.91	6.70	3.07
3.91	2.31	4.61	2.53	5.31	2.73	6.01	2.91	6.71	3.07
3.92	2.32	4.62	2.54	5.32	2.73	6.02	2.91	6.72	3.07
3.93	2.32	4.63	2.54	5.33	2.73	6.03	2.91	6.73	3.08
3.94	2.32	4.64	2.54	5.34	2.74	6.04	2.91	6.74	3.08
3.95	2.33	4.65	2.54	5.35	2.74	6.05	2.92	6.75	3.08
3.96	2.33	4.66	2.55	5.36	2.74	6.06	2.92	6.76	3.08
3.97	2.33	4.67	2.55	5.37	2.74	6.07	2.92	6.77	3.09
3.98	2.34	4.68	2.55	5.38	2.75	6.08	2.92	6.78	3.09
3.99	2.34	4.69	2.56	5.39	2.75	6.09	2.93	6.79	3.09
4.00	2.34	4.70	2.56	5.40	2.75	6.10	2.93	6.80	3.09
4.01	2.35	4.71	2.56	5.41	2.76	6.11	2.93	6.81	3.10
4.02	2.35	4.72	2.56	5.42	2.76	6.12	2.93	6.82	3.10
4.03	2.35	4.73	2.57	5.43	2.76	6.13	2.94	6.83	3.10
4.04	2.36	4.74	2.57	5.44	2.76	6.14	2.94	6.84	3.10
4.05	2.36	4.75	2.57	5.45	2.77	6.15	2.94	6.85	3.10
4.06	2.36	4.76	2.58	5.46	2.77	6.16	2.94	6.86	3.11
4.07	2.37	4.77	2.58	5.47	2.77	6.17	2.95	6.87	3.11
4.08	2.37	4.78	2.58	5.48	2.77	6.18	2.95	6.88	3.11
4.09	2.37	4.79	2.58	5.49	2.78	6.19	2.95	6.89	3.11
4.10	2.37	4.80	2.59	5.50	2.78	6.20	2.95	6.90	3.12
4.11	2.38	4.81	2.59	5.51	2.78	6.21	2.96	6.91	3.12
4.12	2.38	4.82	2.59	5.52	2.78	6.22	2.96	6.92	3.12
4.13	2.38	4.83	2.60	5.53	2.79	6.23	2.96	6.93	3.12
4.14	2.39	4.84	2.60	5.54	2.79	6.24	2.96	6.94	3.12
4.15	2.39	4.85	2.60	5.55	2.79	6.25	2.97	6.95	3.13
4.16	2.39	4.86	2.61	5.56	2.79	6.26	2.97	6.96	3.13
4.17	2.40	4.87	2.61	5.57	2.80	6.27	2.97	6.97	3.13
4.18	2.40	4.88	2.61	5.58	2.80	6.28	2.97	6.98	3.13
4.19	2.40	4.89	2.61	5.59	2.80	6.29	2.97	6.99	3.14
4.20	2.41	4.90	2.62	5.60	2.80	6.30	2.98	7.00	3.14

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TABLE 1 *Continued*

Y	V	Y	V	Y	V	Y	V	Y	V
7.01	3.14	7.71	3.29	8.41	3.43	9.11	3.56	9.81	3.69
7.02	3.14	7.72	3.29	8.42	3.43	9.12	3.56	9.82	3.69
7.03	3.14	7.73	3.29	8.43	3.43	9.13	3.57	9.83	3.69
7.04	3.15	7.74	3.30	8.44	3.44	9.14	3.57	9.84	3.69
7.05	3.15	7.75	3.30	8.45	3.44	9.15	3.57	9.85	3.70
7.06	3.15	7.76	3.30	8.46	3.44	9.16	3.57	9.86	3.70
7.07	3.15	7.77	3.30	8.47	3.44	9.17	3.57	9.87	3.70
7.08	3.16	7.78	3.30	8.48	3.44	9.18	3.58	9.88	3.70
7.09	3.16	7.79	3.31	8.49	3.45	9.19	3.58	9.89	3.70
7.10	3.16	7.80	3.31	8.50	3.45	9.20	3.58	9.90	3.70
7.11	3.16	7.81	3.31	8.51	3.45	9.21	3.58	9.91	3.71
7.12	3.16	7.82	3.31	8.52	3.45	9.22	3.58	9.92	3.71
7.13	3.17	7.83	3.31	8.53	3.45	9.23	3.59	9.93	3.71
7.14	3.17	7.84	3.32	8.54	3.46	9.24	3.59	9.94	3.71
7.15	3.17	7.85	3.32	8.55	3.46	9.25	3.59	9.95	3.71
7.16	3.17	7.86	3.32	8.56	3.46	9.26	3.59	9.96	3.71
7.17	3.18	7.87	3.32	8.57	3.46	9.27	3.59	9.97	3.72
7.18	3.18	7.88	3.32	8.58	3.46	9.28	3.59	9.98	3.72
7.19	3.18	7.89	3.33	8.59	3.47	9.29	3.60	9.99	3.72
7.20	3.18	7.90	3.33	8.60	3.47	9.30	3.60	10.00	3.72
7.21	3.18	7.91	3.33	8.61	3.47	9.31	3.60	10.01	3.72
7.22	3.19	7.92	3.33	8.62	3.47	9.32	3.60	10.02	3.72
7.23	3.19	7.93	3.34	8.63	3.47	9.33	3.60	10.03	3.73
7.24	3.19	7.94	3.34	8.64	3.48	9.34	3.60	10.04	3.73
7.25	3.19	7.95	3.34	8.65	3.48	9.35	3.61	10.05	3.73
7.26	3.19	7.96	3.34	8.66	3.48	9.36	3.61	10.06	3.73
7.27	3.20	7.97	3.34	8.67	3.48	9.37	3.61	10.07	3.73
7.28	3.20	7.98	3.35	8.68	3.48	9.38	3.61	10.08	3.73
7.29	3.20	7.99	3.35	8.69	3.48	9.39	3.61	10.09	3.74
7.30	3.20	8.00	3.35	8.70	3.49	9.40	3.62	10.10	3.74
7.31	3.21	8.01	3.35	8.71	3.49	9.41	3.62	10.11	3.74
7.32	3.21	8.02	3.35	8.72	3.49	9.42	3.62	10.12	3.74
7.33	3.21	8.03	3.36	8.73	3.49	9.43	3.62	10.13	3.74
7.34	3.21	8.04	3.36	8.74	3.49	9.44	3.62	10.14	3.74
7.35	3.21	8.05	3.36	8.75	3.50	9.45	3.62	10.15	3.75
7.36	3.22	8.06	3.36	8.76	3.50	9.46	3.63	10.16	3.75
7.37	3.22	8.07	3.36	8.77	3.50	9.47	3.63	10.17	3.75
7.38	3.22	8.08	3.37	8.78	3.50	9.48	3.63	10.18	3.75
7.39	3.22	8.09	3.37	8.79	3.50	9.49	3.63	10.19	3.75
7.40	3.22	8.10	3.37	8.80	3.51	9.50	3.63	10.20	3.76
7.41	3.23	8.11	3.37	8.81	3.51	9.51	3.64	10.21	3.76
7.42	3.23	8.12	3.37	8.82	3.51	9.52	3.64	10.22	3.76
7.43	3.23	8.13	3.38	8.83	3.51	9.53	3.64	10.23	3.76
7.44	3.23	8.14	3.38	8.84	3.51	9.54	3.64	10.24	3.76
7.45	3.24	8.15	3.38	8.85	3.51	9.55	3.64	10.25	3.76
7.46	3.24	8.16	3.38	8.86	3.52	9.56	3.64	10.26	3.77
7.47	3.24	8.17	3.38	8.87	3.52	9.57	3.65	10.27	3.77
7.48	3.24	8.18	3.39	8.88	3.52	9.58	3.65	10.28	3.77
7.49	3.24	8.19	3.39	8.89	3.52	8.59	3.65	10.29	3.77
7.50	3.25	8.20	3.39	8.90	3.52	9.60	3.65	10.30	3.77
7.51	3.25	8.21	3.39	8.91	3.53	9.61	3.65	10.31	3.77
7.52	3.25	8.22	3.39	8.92	3.53	9.62	3.65	10.32	3.78
7.53	3.25	8.23	3.40	8.93	3.53	9.63	3.66	10.33	3.78
7.54	3.25	8.24	3.40	8.94	3.53	9.64	3.66	10.34	3.78
7.55	3.26	8.25	3.40	8.95	3.53	9.65	3.66	10.35	3.78
7.56	3.26	8.26	3.40	8.96	3.54	9.66	3.66	10.36	3.78
7.57	3.26	8.27	3.40	8.97	3.54	9.67	3.66	10.37	3.78
7.58	3.26	8.28	3.41	8.98	3.54	9.68	3.67	10.38	3.79
7.59	3.26	8.29	3.41	8.99	3.54	9.69	3.67	10.39	3.79
7.60	3.27	8.30	3.41	9.00	3.54	9.70	3.67	10.40	3.79
7.61	3.27	8.31	3.41	9.01	3.54	9.71	3.67	10.41	3.79
7.62	3.27	8.32	3.41	9.02	3.55	9.72	3.67	10.42	3.79
7.63	3.27	8.33	3.41	9.03	3.55	9.73	3.67	10.43	3.79
7.64	3.28	8.34	3.42	9.04	3.55	9.74	3.68	10.44	3.80
7.65	3.28	8.35	3.42	9.05	3.55	9.75	3.68	10.45	3.80
7.66	3.28	8.36	3.42	9.06	3.55	9.76	3.68	10.46	3.80
7.67	3.28	8.37	3.42	9.07	3.56	9.77	3.68	10.47	3.80
7.68	3.28	8.38	3.42	9.08	3.56	9.78	3.68	10.48	3.80
7.69	3.29	8.39	3.43	9.09	3.56	9.79	3.68	10.49	3.80
7.70	3.29	8.40	3.43	9.10	3.56	9.80	3.69	10.50	3.81

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TABLE 1 *Continued*

Y	V	Y	V	Y	V	Y	V	Y	V
10.51	3.81	11.21	3.92	11.91	4.03	12.61	4.14	13.31	4.24
10.52	3.81	11.22	3.92	11.92	4.03	12.62	4.14	13.32	4.24
10.53	3.81	11.23	3.92	11.93	4.03	12.63	4.14	13.33	4.24
10.54	3.81	11.24	3.93	11.94	4.04	12.64	4.14	13.34	4.25
10.55	3.81	11.25	3.93	11.95	4.04	12.65	4.14	13.35	4.25
10.56	3.82	11.26	3.93	11.96	4.04	12.66	4.15	13.36	4.25
10.57	3.82	11.27	3.93	11.97	4.04	12.67	4.15	13.37	4.25
10.58	3.82	11.28	3.93	11.98	4.04	12.68	4.15	13.38	4.25
10.59	3.82	11.29	3.93	11.99	4.04	12.69	4.15	13.39	4.25
10.60	3.82	11.30	3.94	12.00	4.05	12.70	4.15	13.40	4.25
10.61	3.82	11.31	3.94	12.01	4.05	12.71	4.15	13.41	4.26
10.62	3.83	11.32	3.94	12.02	4.05	12.72	4.15	13.42	4.26
10.63	3.83	11.33	3.94	12.03	4.05	12.73	4.16	13.43	4.26
10.64	3.83	11.34	3.94	12.04	4.05	12.74	4.16	13.44	4.26
10.65	3.83	11.35	3.94	12.05	4.05	12.75	4.16	13.45	4.26
10.66	3.83	11.36	3.95	12.06	4.05	12.76	4.16	13.46	4.26
10.67	3.83	11.37	3.95	12.07	4.06	12.77	4.16	13.47	4.26
10.68	3.84	11.38	3.95	12.08	4.06	12.78	4.16	13.48	4.27
10.69	3.84	11.39	3.95	12.09	4.06	12.79	4.16	13.49	4.27
10.70	3.84	11.40	3.95	12.10	4.06	12.80	4.17	13.50	4.27
10.71	3.84	11.41	3.95	12.11	4.06	12.81	4.17	13.51	4.27
10.72	3.84	11.42	3.95	12.12	4.06	12.82	4.17	13.52	4.27
10.73	3.84	11.43	3.96	12.13	4.07	12.83	4.17	13.53	4.27
10.74	3.85	11.44	3.96	12.14	4.07	12.84	4.17	13.54	4.27
10.75	3.85	11.45	3.96	12.15	4.07	12.85	4.17	13.55	4.28
10.76	3.85	11.46	3.96	12.16	4.07	12.86	4.18	13.56	4.28
10.77	3.85	11.47	3.96	12.17	4.07	12.87	4.18	13.57	4.28
10.78	3.85	11.48	3.96	12.18	4.07	12.88	4.18	13.58	4.28
10.79	3.85	11.49	3.97	12.19	4.07	12.89	4.18	13.59	4.28
10.80	3.85	11.50	3.97	12.20	4.08	12.90	4.18	13.60	4.28
10.81	3.86	11.51	3.97	12.21	4.08	12.91	4.18	13.61	4.28
10.82	3.86	11.52	3.97	12.22	4.08	12.92	4.18	13.62	4.29
10.83	3.86	11.53	3.97	12.23	4.08	12.93	4.19	13.63	4.29
10.84	3.86	11.54	3.97	12.24	4.08	12.94	4.19	13.64	4.29
10.85	3.86	11.55	3.98	12.25	4.08	12.95	4.19	13.65	4.29
10.86	3.86	11.56	3.98	12.26	4.09	12.96	4.19	13.66	4.29
10.87	3.87	11.57	3.98	12.27	4.09	12.97	4.19	13.67	4.29
10.88	3.87	11.58	3.98	12.28	4.09	12.98	4.19	13.68	4.29
10.89	3.87	11.59	3.98	12.29	4.09	12.99	4.19	13.69	4.30
10.90	3.87	11.60	3.98	12.30	4.09	13.00	4.20	13.70	4.30
10.91	3.87	11.61	3.98	12.31	4.09	13.01	4.20	13.71	4.30
10.92	3.87	11.62	3.99	12.32	4.09	13.02	4.20	13.72	4.30
10.93	3.88	11.63	3.99	12.33	4.10	13.03	4.20	13.73	4.30
10.94	3.88	11.64	3.99	12.34	4.10	13.04	4.20	13.74	4.30
10.95	3.88	11.65	3.99	12.35	4.10	13.05	4.20	13.75	4.30
10.96	3.88	11.66	3.99	12.36	4.10	13.06	4.20	13.76	4.31
10.97	3.88	11.67	3.99	12.37	4.10	13.07	4.21	13.77	4.31
10.98	3.88	11.68	4.00	12.38	4.10	13.08	4.21	13.78	4.31
10.99	3.89	11.69	4.00	12.39	4.10	13.09	4.21	13.79	4.31
11.00	3.89	11.70	4.00	12.40	4.11	13.10	4.21	13.80	4.31
11.01	3.89	11.71	4.00	12.41	4.11	13.11	4.21	13.81	4.31
11.02	3.89	11.72	4.00	12.42	4.11	13.12	4.21	13.82	4.31
11.03	3.89	11.73	4.00	12.43	4.11	13.13	4.21	13.83	4.32
11.04	3.89	11.74	4.00	12.44	4.11	13.14	4.22	13.84	4.32
11.05	3.90	11.75	4.01	12.45	4.11	13.15	4.22	13.85	4.32
11.06	3.90	11.76	4.01	12.46	4.12	13.16	4.22	13.86	4.32
11.07	3.90	11.77	4.01	12.47	4.12	13.17	4.22	13.87	4.32
11.08	3.90	11.78	4.01	12.48	4.12	13.18	4.22	13.88	4.32
11.09	3.90	11.79	4.01	12.49	4.12	13.19	4.22	13.89	4.32
11.10	3.90	11.80	4.01	12.50	4.12	13.20	4.22	13.90	4.32
11.11	3.91	11.81	4.02	12.51	4.12	13.21	4.23	13.91	4.33
11.12	3.91	11.82	4.02	12.52	4.12	13.22	4.23	13.92	4.33
11.13	3.91	11.83	4.02	12.53	4.13	13.23	4.23	13.93	4.33
11.14	3.91	11.84	4.02	12.54	4.13	13.24	4.23	13.94	4.33
11.15	3.91	11.85	4.02	12.55	4.13	13.25	4.23	13.95	4.33
11.16	3.91	11.86	4.02	12.56	4.13	13.26	4.23	13.96	4.33
11.17	3.91	11.87	4.03	12.57	4.13	13.27	4.24	13.97	4.33
11.18	3.92	11.88	4.03	12.58	4.13	13.28	4.24	13.98	4.34
11.19	3.92	11.89	4.03	12.59	4.13	13.29	4.24	13.99	4.34
11.20	3.92	11.90	4.03	12.60	4.14	13.30	4.24	14.00	4.34

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TABLE 1 *Continued*

Y	V	Y	V	Y	V	Y	V	Y	V
14.01	4.34	14.71	4.44	15.41	4.53	16.11	4.62	16.81	4.71
14.02	4.34	14.72	4.44	15.42	4.53	16.12	4.62	16.82	4.71
14.03	4.34	14.73	4.44	15.43	4.53	16.13	4.62	16.83	4.71
14.04	4.34	14.74	4.44	15.44	4.53	16.14	4.62	16.84	4.71
14.05	4.35	14.75	4.44	15.45	4.53	16.15	4.62	16.85	4.71
14.06	4.35	14.76	4.44	15.46	4.54	16.16	4.63	16.86	4.71
14.07	4.35	14.77	4.44	15.47	4.54	16.17	4.63	16.87	4.72
14.08	4.35	14.78	4.45	15.48	4.54	16.18	4.63	16.88	4.72
14.09	4.35	14.79	4.45	15.49	4.54	16.19	4.63	16.89	4.72
14.10	4.35	14.80	4.45	15.50	4.54	16.20	4.63	16.90	4.72
14.11	4.35	14.81	4.45	15.51	4.54	16.21	4.63	16.91	4.72
14.12	4.36	14.82	4.45	15.52	4.54	16.22	4.63	16.92	4.72
14.13	4.36	14.83	4.45	15.53	4.54	16.23	4.64	16.93	4.72
14.14	4.36	14.84	4.45	15.54	4.55	16.24	4.64	16.94	4.72
14.15	4.36	14.85	4.46	15.55	4.55	16.25	4.64	16.95	4.73
14.16	4.36	14.86	4.46	15.56	4.55	16.26	4.64	16.96	4.73
14.17	4.36	14.87	4.46	15.57	4.55	16.27	4.64	16.97	4.73
14.18	4.36	14.88	4.46	15.58	4.55	16.28	4.64	16.98	4.73
14.19	4.37	14.89	4.46	15.59	4.55	16.29	4.64	16.99	4.73
14.20	4.37	14.90	4.46	15.60	4.55	16.30	4.64	17.00	4.73
14.21	4.37	14.91	4.46	15.61	4.56	16.31	4.65	17.01	4.73
14.22	4.37	14.92	4.46	15.62	4.56	16.32	4.65	17.02	4.73
14.23	4.37	14.93	4.47	15.63	4.56	16.33	4.65	17.03	4.74
14.24	4.37	14.94	4.47	15.64	4.56	16.34	4.65	17.04	4.74
14.25	4.37	14.95	4.47	15.65	4.56	16.35	4.65	17.05	4.74
14.26	4.37	14.96	4.47	15.66	4.56	16.36	4.65	17.06	4.74
14.27	4.38	14.97	4.47	15.67	4.56	16.37	4.65	17.07	4.74
14.28	4.38	14.98	4.47	15.68	4.56	16.38	4.65	17.08	4.74
14.29	4.38	14.99	4.47	15.69	4.57	16.39	4.66	17.09	4.74
14.30	4.38	15.00	4.48	15.70	4.57	16.40	4.66	17.10	4.74
14.31	4.38	15.01	4.48	15.71	4.57	16.41	4.66	17.11	4.75
14.32	4.38	15.02	4.48	15.72	4.57	16.42	4.66	17.12	4.75
14.33	4.38	15.03	4.48	15.73	4.57	16.43	4.66	17.13	4.75
14.34	4.39	15.04	4.48	15.74	4.57	16.44	4.66	17.14	4.75
14.35	4.39	15.05	4.48	15.75	4.57	16.45	4.66	17.15	4.75
14.36	4.39	15.06	4.48	15.76	4.57	16.46	4.66	17.16	4.75
14.37	4.39	15.07	4.48	15.77	4.58	16.47	4.67	17.17	4.75
14.38	4.39	15.08	4.49	15.78	4.58	16.48	4.67	17.18	4.75
14.39	4.39	15.09	4.49	15.79	4.58	16.49	4.67	17.19	4.76
14.40	4.39	15.10	4.49	15.80	4.58	16.50	4.67	17.20	4.76
14.41	4.40	15.11	4.49	15.81	4.58	16.51	4.67	17.21	4.76
14.42	4.40	15.12	4.49	15.82	4.58	16.52	4.67	17.22	4.76
14.43	4.40	15.13	4.49	15.83	4.58	16.53	4.67	17.23	4.76
14.44	4.40	15.14	4.49	15.84	4.59	16.54	4.67	17.24	4.76
14.45	4.40	15.15	4.50	15.85	4.59	16.55	4.68	17.25	4.76
14.46	4.40	15.16	4.50	15.86	4.59	16.56	4.68	17.26	4.76
14.47	4.40	15.17	4.50	15.87	4.59	16.57	4.68	17.27	4.77
14.48	4.41	15.18	4.50	15.88	4.59	16.58	4.68	17.28	4.77
14.49	4.41	15.19	4.50	15.89	4.59	16.59	4.68	17.29	4.77
14.50	4.41	15.20	4.50	15.90	4.59	16.60	4.68	17.30	4.77
14.51	4.41	15.21	4.50	15.91	4.59	16.61	4.68	17.31	4.77
14.52	4.41	15.22	4.50	15.92	4.60	16.62	4.68	17.32	4.77
14.53	4.41	15.23	4.51	15.93	4.60	16.63	4.69	17.33	4.77
14.54	4.41	15.24	4.51	15.94	4.60	16.64	4.69	17.34	4.77
14.55	4.41	15.25	4.51	15.95	4.60	16.65	4.69	17.35	4.78
14.56	4.42	15.26	4.51	15.96	4.60	16.66	4.69	17.36	4.78
14.57	4.42	15.27	4.51	15.97	4.60	16.67	4.69	17.37	4.78
14.58	4.42	15.28	4.51	15.98	4.60	16.68	4.69	17.38	4.78
14.59	4.42	15.29	4.51	15.99	4.60	16.69	4.69	17.39	4.78
14.60	4.42	15.30	4.51	16.00	4.61	16.70	4.69	17.40	4.78
14.61	4.42	15.31	4.52	16.01	4.61	16.71	4.70	17.41	4.78
14.62	4.42	15.32	4.52	16.02	4.61	16.72	4.70	17.42	4.78
14.63	4.43	15.33	4.52	16.03	4.61	16.73	4.70	17.43	4.79
14.64	4.43	15.34	4.52	16.04	4.61	16.74	4.70	17.44	4.79
14.65	4.43	15.35	4.52	16.05	4.61	16.75	4.70	17.45	4.79
14.66	4.43	15.36	4.52	16.06	4.61	16.76	4.70	17.46	4.79
14.67	4.43	15.37	4.52	16.07	4.61	16.77	4.70	17.47	4.79
14.68	4.43	15.38	4.53	16.08	4.62	16.78	4.70	17.48	4.79
14.69	4.43	15.39	4.53	16.09	4.62	16.79	4.71	17.49	4.79
14.70	4.43	15.40	4.53	16.10	4.62	16.80	4.71	17.50	4.79

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TABLE 1 *Continued*

Y	V	Y	V	Y	V	Y	V	Y	V
17.51	4.79	18.21	4.88	18.91	4.96	19.61	5.04	20.31	5.12
17.52	4.80	18.22	4.88	18.92	4.96	19.62	5.04	20.32	5.12
17.53	4.80	18.23	4.88	18.93	4.96	19.63	5.04	20.33	5.12
17.54	4.80	18.24	4.88	18.94	4.96	19.64	5.04	20.34	5.12
17.55	4.80	18.25	4.88	18.95	4.97	19.65	5.05	20.35	5.12
17.56	4.80	18.26	4.89	18.96	4.97	19.66	5.05	20.36	5.12
17.57	4.80	18.27	4.89	18.97	4.97	19.67	5.05	20.37	5.13
17.58	4.80	18.28	4.89	18.98	4.97	19.68	5.05	20.38	5.13
17.59	4.80	18.29	4.89	18.99	4.97	19.69	5.05	20.39	5.13
17.60	4.81	18.30	4.89	19.00	4.97	19.70	5.05	20.40	5.13
17.61	4.81	18.31	4.89	19.01	4.97	19.71	5.05	20.41	5.13
17.62	4.81	18.32	4.89	19.02	4.97	19.72	5.05	20.42	5.13
17.63	4.81	18.33	4.89	19.03	4.98	19.73	5.05	20.43	5.13
17.64	4.81	18.34	4.89	19.04	4.98	19.74	5.06	20.44	5.13
17.65	4.81	18.35	4.90	19.05	4.98	19.75	5.06	20.45	5.13
17.66	4.81	18.36	4.90	19.06	4.98	19.76	5.06	20.46	5.14
17.67	4.81	18.37	4.90	19.07	4.98	19.77	5.06	20.47	5.14
17.68	4.82	18.38	4.90	19.08	4.98	19.78	5.06	20.48	5.14
17.69	4.82	18.39	4.90	19.09	4.98	19.79	5.06	20.49	5.14
17.70	4.82	18.40	4.90	19.10	4.98	19.80	5.06	20.50	5.14
17.71	4.82	18.41	4.90	19.11	4.98	19.81	5.06	20.51	5.14
17.72	4.82	18.42	4.90	19.12	4.99	19.82	5.07	20.52	5.14
17.73	4.82	18.43	4.91	19.13	4.99	19.83	5.07	20.53	5.14
17.74	4.82	18.44	4.91	19.14	4.99	19.84	5.07	20.54	5.14
17.75	4.82	18.45	4.91	19.15	4.99	19.85	5.07	20.55	5.15
17.76	4.83	18.46	4.91	19.16	4.99	19.86	5.07	20.56	5.15
17.77	4.83	18.47	4.91	19.17	4.99	19.87	5.07	20.57	5.15
17.78	4.83	18.48	4.91	19.18	4.99	19.88	5.07	20.58	5.15
17.79	4.83	18.49	4.91	19.19	4.99	19.89	5.07	20.59	5.15
17.80	4.83	18.50	4.91	19.20	4.99	19.90	5.07	20.60	5.15
17.81	4.83	18.51	4.91	19.21	5.00	19.91	5.08	20.61	5.15
17.82	4.83	18.52	4.92	19.22	5.00	19.92	5.08	20.62	5.15
17.83	4.83	18.53	4.92	19.23	5.00	19.93	5.08	20.63	5.15
17.84	4.83	18.54	4.92	19.24	5.00	19.94	5.08	20.64	5.16
17.85	4.84	18.55	4.92	19.25	5.00	19.95	5.08	20.65	5.16
17.86	4.84	18.56	4.92	19.26	5.00	19.96	5.08	20.66	5.16
17.87	4.84	18.57	4.92	19.27	5.00	19.97	5.08	20.67	5.16
17.88	4.84	18.58	4.92	19.28	5.00	19.98	5.08	20.68	5.16
17.89	4.84	18.59	4.92	19.29	5.01	19.99	5.08	20.69	5.16
17.90	4.84	18.60	4.93	19.30	5.01	20.00	5.09	20.70	5.16
17.91	4.84	18.61	4.93	19.31	5.01	20.01	5.09	20.71	5.16
17.92	4.84	18.62	4.93	19.32	5.01	20.02	5.09	20.72	5.16
17.93	4.85	18.63	4.93	19.33	5.01	20.03	5.09	20.73	5.17
17.94	4.85	18.64	4.93	19.34	5.01	20.04	5.09	20.74	5.17
17.95	4.85	18.65	4.93	19.35	5.01	20.05	5.09	20.75	5.17
17.96	4.85	18.66	4.93	19.36	5.01	20.06	5.09	20.76	5.17
17.97	4.85	18.67	4.93	19.37	5.01	20.07	5.09	20.77	5.17
17.98	4.85	18.68	4.93	19.38	5.02	20.08	5.09	20.78	5.17
17.99	4.85	18.69	4.94	19.39	5.02	20.09	5.10	20.79	5.17
18.00	4.85	18.70	4.94	19.40	5.02	20.10	5.10	20.80	5.17
18.01	4.86	18.71	4.94	19.41	5.02	20.11	5.10	20.81	5.17
18.02	4.86	18.72	4.94	19.42	5.02	20.12	5.10	20.82	5.18
18.03	4.86	18.73	4.94	19.43	5.02	20.13	5.10	20.83	5.18
18.04	4.86	18.74	4.94	19.44	5.02	20.14	5.10	20.84	5.18
18.05	4.86	18.75	4.94	19.45	5.02	20.15	5.10	20.85	5.18
18.06	4.86	18.76	4.94	19.46	5.02	20.16	5.10	20.86	5.18
18.07	4.86	18.77	4.95	19.47	5.03	20.17	5.10	20.87	5.18
18.08	4.86	18.78	4.95	19.48	5.03	20.18	5.11	20.88	5.18
18.09	4.86	18.79	4.95	19.49	5.03	20.19	5.11	20.89	5.18
18.10	4.87	18.80	4.95	19.50	5.03	20.20	5.11	20.90	5.18
18.11	4.87	18.81	4.95	19.51	5.03	20.21	5.11	20.91	5.18
18.12	4.87	18.82	4.95	19.52	5.03	20.22	5.11	20.92	5.19
18.13	4.87	18.83	4.95	19.53	5.03	20.23	5.11	20.93	5.19
18.14	4.87	18.84	4.95	19.54	5.03	20.24	5.11	20.94	5.19
18.15	4.87	18.85	4.95	19.55	5.03	20.25	5.11	20.95	5.19
18.16	4.87	18.86	4.96	19.56	5.04	20.26	5.11	20.96	5.19
18.17	4.87	18.87	4.96	19.57	5.04	20.27	5.11	20.97	5.19
18.18	4.88	18.88	4.96	19.58	5.04	20.28	5.12	20.98	5.19
18.19	4.88	18.89	4.96	19.59	5.04	20.29	5.12	20.99	5.19
18.20	4.88	18.90	4.96	19.60	5.04	20.30	5.12	21.00	5.19

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TABLE 1 *Continued*

Y	V	Y	V	Y	V	Y	V	Y	V
21.01	5.20	21.71	5.27	22.41	5.34	23.11	5.42	23.81	5.49
21.02	5.20	21.72	5.27	22.42	5.35	23.12	5.42	23.82	5.49
21.03	5.20	21.73	5.27	22.43	5.35	23.13	5.42	23.83	5.49
21.04	5.20	21.74	5.27	22.44	5.35	23.14	5.42	23.84	5.49
21.05	5.20	21.75	5.27	22.45	5.35	23.15	5.42	23.85	5.49
21.06	5.20	21.76	5.28	22.46	5.35	23.16	5.42	23.86	5.49
21.07	5.20	21.77	5.28	22.47	5.35	23.17	5.42	23.87	5.49
21.08	5.20	21.78	5.28	22.48	5.35	23.18	5.42	23.88	5.49
21.09	5.20	21.79	5.28	22.49	5.35	23.19	5.42	23.89	5.49
21.10	5.21	21.80	5.28	22.50	5.35	23.20	5.43	23.90	5.50
21.11	5.21	21.81	5.28	22.51	5.35	23.21	5.43	23.91	5.50
21.12	5.21	21.82	5.28	22.52	5.36	23.22	5.43	23.92	5.50
21.13	5.21	21.83	5.28	22.53	5.36	23.23	5.43	23.93	5.50
21.14	5.21	21.84	5.28	22.54	5.36	23.24	5.43	23.94	5.50
21.15	5.21	21.85	5.29	22.55	5.36	23.25	5.43	23.95	5.50
21.16	5.21	21.86	5.29	22.56	5.36	23.26	5.43	23.96	5.50
21.17	5.21	21.87	5.29	22.57	5.36	23.27	5.43	23.97	5.50
21.18	5.21	21.88	5.29	22.58	5.36	23.28	5.43	23.98	5.50
21.19	5.21	21.89	5.29	22.59	5.36	23.29	5.43	23.99	5.50
21.20	5.22	21.90	5.29	22.60	5.36	23.30	5.44	24.0	5.51
21.21	5.22	21.91	5.29	22.61	5.36	23.31	5.44	24.1	5.52
21.22	5.22	21.92	5.29	22.62	5.37	23.32	5.44	24.2	5.53
21.23	5.22	21.93	5.29	22.63	5.37	23.33	5.44	24.3	5.54
21.24	5.22	21.94	5.29	22.64	5.37	23.34	5.44	24.4	5.55
21.25	5.22	21.95	5.30	22.65	5.37	23.35	5.44	24.5	5.55
21.26	5.22	21.96	5.30	22.66	5.37	23.36	5.44	24.6	5.56
21.27	5.22	21.97	5.30	22.67	5.37	23.37	5.44	24.7	5.57
21.28	5.22	21.98	5.30	22.68	5.37	23.38	5.44	24.8	5.58
21.29	5.23	21.99	5.30	22.69	5.37	23.39	5.44	24.9	5.59
21.30	5.23	22.00	5.30	22.70	5.37	23.40	5.45	25.0	5.60
21.31	5.23	22.01	5.30	22.71	5.38	23.41	5.45	25.1	5.61
21.32	5.23	22.02	5.30	22.72	5.38	23.42	5.45	25.2	5.62
21.33	5.23	22.03	5.30	22.73	5.38	23.43	5.45	25.3	5.63
21.34	5.23	22.04	5.31	22.74	5.38	23.44	5.45	25.4	5.64
21.35	5.23	22.05	5.31	22.75	5.38	23.45	5.45	25.5	5.65
21.36	5.23	22.06	5.31	22.76	5.38	23.46	5.45	25.6	5.66
21.37	5.23	22.07	5.31	22.77	5.38	23.47	5.45	25.7	5.67
21.38	5.24	22.08	5.31	22.78	5.38	23.48	5.45	25.8	5.68
21.39	5.24	22.09	5.31	22.79	5.38	23.49	5.45	25.9	5.69
21.40	5.24	22.10	5.31	22.80	5.38	23.50	5.46	26.0	5.70
21.41	5.24	22.11	5.31	22.81	5.39	23.51	5.46	26.1	5.71
21.42	5.24	22.12	5.31	22.82	5.39	23.52	5.46	26.2	5.72
21.43	5.24	22.13	5.31	22.83	5.39	23.53	5.46	26.3	5.73
21.44	5.24	22.14	5.32	22.84	5.39	23.54	5.46	26.4	5.74
21.45	5.24	22.15	5.32	22.85	5.39	23.55	5.46	26.5	5.75
21.46	5.24	22.16	5.32	22.86	5.39	23.56	5.46	26.6	5.75
21.47	5.24	22.17	5.32	22.87	5.39	23.57	5.46	26.7	5.76
21.48	5.25	22.18	5.32	22.88	5.39	23.58	5.46	26.8	5.77
21.49	5.25	22.19	5.32	22.89	5.39	23.59	5.46	26.9	5.78
21.50	5.25	22.20	5.32	22.90	5.39	23.60	5.47	27.0	5.79
21.51	5.25	22.21	5.32	22.91	5.40	23.61	5.47	27.1	5.80
21.52	5.25	22.22	5.32	22.92	5.40	23.62	5.47	27.2	5.81
21.53	5.25	22.23	5.33	22.93	5.40	23.63	5.47	27.3	5.82
21.54	5.25	22.24	5.33	22.94	5.40	23.64	5.47	27.4	5.83
21.55	5.25	22.25	5.33	22.95	5.40	23.65	5.47	27.5	5.84
21.56	5.25	22.26	5.33	22.96	5.40	23.66	5.47	27.6	5.85
21.57	5.26	22.27	5.33	22.97	5.40	23.67	5.47	27.7	5.86
21.58	5.26	22.28	5.33	22.98	5.40	23.68	5.47	27.8	5.87
21.59	5.26	22.29	5.33	22.99	5.40	23.69	5.47	27.9	5.87
21.60	5.26	22.30	5.33	23.00	5.40	23.70	5.48	28.0	5.88
21.61	5.26	22.31	5.33	23.01	5.41	23.71	5.48	28.1	5.89
21.62	5.26	22.32	5.33	23.02	5.41	23.72	5.48	28.2	5.90
21.63	5.26	22.33	5.34	23.03	5.41	23.73	5.48	28.3	5.91
21.64	5.26	22.34	5.34	23.04	5.41	23.74	5.48	28.4	5.92
21.65	5.26	22.35	5.34	23.05	5.41	23.75	5.48	28.5	5.93
21.66	5.27	22.36	5.34	23.06	5.41	23.76	5.48	28.6	5.94
21.67	5.27	22.37	5.34	23.07	5.41	23.77	5.48	28.7	5.95
21.68	5.27	22.38	5.34	23.08	5.41	23.78	5.48	28.8	5.96
21.69	5.27	22.39	5.34	23.09	5.41	23.79	5.48	28.9	5.96
21.70	5.27	22.40	5.34	23.10	5.42	23.80	5.49	29.0	5.97

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TABLE 1 *Continued*

Y	V	Y	V	Y	V	Y	V	Y	V
29.1	5.98	36.1	6.56	43.1	7.08	50.1	7.55	57.1	7.97
29.2	5.99	36.2	6.57	43.2	7.09	50.2	7.55	57.2	7.98
29.3	6.00	36.3	6.58	43.3	7.10	50.3	7.56	57.3	7.98
29.4	6.01	36.4	6.59	43.4	7.10	50.4	7.57	57.4	7.99
29.5	6.02	36.5	6.60	43.5	7.11	50.5	7.57	57.5	7.99
29.6	6.03	36.6	6.60	43.6	7.12	50.6	7.58	57.6	8.00
29.7	6.03	36.7	6.61	43.7	7.12	50.7	7.59	57.7	8.01
29.8	6.04	36.8	6.62	43.8	7.13	50.8	7.59	57.8	8.01
29.9	6.05	36.9	6.63	43.9	7.14	50.9	7.60	57.9	8.02
30.0	6.06	37.0	6.63	44.0	7.14	51.0	7.60	58.0	8.02
30.1	6.07	37.1	6.64	44.1	7.15	51.1	7.61	58.1	8.03
30.2	6.08	37.2	6.65	44.2	7.16	51.2	7.62	58.2	8.03
30.3	6.09	37.3	6.66	44.3	7.16	51.3	7.62	58.3	8.04
30.4	6.10	37.4	6.67	44.4	7.17	51.4	7.63	58.4	8.05
30.5	6.10	37.5	6.67	44.5	7.18	51.5	7.64	58.5	8.05
30.6	6.11	37.6	6.68	44.6	7.19	51.6	7.64	58.6	8.06
30.7	6.12	37.7	6.69	44.7	7.19	51.7	7.65	58.7	8.06
30.8	6.13	37.8	6.70	44.8	7.20	51.8	7.65	58.8	8.07
30.9	6.14	37.9	6.70	44.9	7.21	51.9	7.66	58.9	8.07
31.0	6.15	38.0	6.71	45.0	7.21	52.0	7.67	59.0	8.08
31.1	6.16	38.1	6.72	45.1	7.22	52.1	7.67	59.1	8.09
31.2	6.16	38.2	6.73	45.2	7.23	52.2	7.68	59.2	8.09
31.3	6.17	38.3	6.73	45.3	7.23	52.3	7.69	59.3	8.10
31.4	6.18	38.4	6.74	45.4	7.24	52.4	7.69	59.4	8.10
31.5	6.19	38.5	6.75	45.5	7.25	52.5	7.70	59.5	8.11
31.6	6.20	38.6	6.76	45.6	7.25	52.6	7.70	59.6	8.11
31.7	6.21	38.7	6.76	45.7	7.26	52.7	7.71	59.7	8.12
31.8	6.21	38.8	6.77	45.8	7.27	52.8	7.72	59.8	8.13
31.9	6.22	38.9	6.78	45.9	7.27	52.9	7.72	59.9	8.13
32.0	6.23	39.0	6.79	46.0	7.28	53.0	7.73	60.0	8.14
32.1	6.24	39.1	6.79	46.1	7.29	53.1	7.73	60.1	8.14
32.2	6.25	39.2	6.80	46.2	7.29	53.2	7.74	60.2	8.15
32.3	6.26	39.3	6.81	46.3	7.30	53.3	7.75	60.3	8.15
32.4	6.27	39.4	6.82	46.4	7.31	53.4	7.75	60.4	8.16
32.5	6.27	39.5	6.82	46.5	7.31	53.5	7.76	60.5	8.16
32.6	6.28	39.6	6.83	46.6	7.32	53.6	7.76	60.6	8.17
32.7	6.29	39.7	6.84	46.7	7.33	53.7	7.77	60.7	8.18
32.8	6.30	39.8	6.85	46.8	7.33	53.8	7.78	60.8	8.18
32.9	6.31	39.9	6.85	46.9	7.34	53.9	7.78	60.9	8.19
33.0	6.32	40.0	6.86	47.0	7.35	54.0	7.79	61.0	8.19
33.1	6.32	40.1	6.87	47.1	7.35	54.1	7.79	61.1	8.20
33.2	6.33	40.2	6.87	47.2	7.36	54.2	7.80	61.2	8.20
33.3	6.34	40.3	6.88	47.3	7.37	54.3	7.81	61.3	8.21
33.4	6.35	40.4	6.89	47.4	7.37	54.4	7.81	61.4	8.21
33.5	6.36	40.5	6.90	47.5	7.38	54.5	7.82	61.5	8.22
33.6	6.36	40.6	6.90	47.6	7.39	54.6	7.82	61.6	8.23
33.7	6.37	40.7	6.91	47.7	7.39	54.7	7.83	61.7	8.23
33.8	6.38	40.8	6.92	47.8	7.40	54.8	7.84	61.8	8.24
33.9	6.39	40.9	6.93	47.9	7.41	54.9	7.84	61.9	8.24
34.0	6.40	41.0	6.93	48.0	7.41	55.0	7.85	62.0	8.25
34.1	6.41	41.1	6.94	48.1	7.42	55.1	7.85	62.1	8.25
34.2	6.41	41.2	6.95	48.2	7.43	55.2	7.86	62.2	8.26
34.3	6.42	41.3	6.95	48.3	7.43	55.3	7.87	62.3	8.26
34.4	6.43	41.4	6.96	48.4	7.44	55.4	7.87	62.4	8.27
34.5	6.44	41.5	6.97	48.5	7.44	55.5	7.88	62.5	8.27
34.6	6.45	41.6	6.98	48.6	7.45	55.6	7.88	62.6	8.28
34.7	6.45	41.7	6.98	48.7	7.46	55.7	7.89	62.7	8.29
34.8	6.46	41.8	6.99	48.8	7.46	55.8	7.90	62.8	8.29
34.9	6.47	41.9	7.00	48.9	7.47	55.9	7.90	62.9	8.30
35.0	6.48	42.0	7.00	49.0	7.48	56.0	7.91	63.0	8.30
35.1	6.49	42.1	7.01	49.1	7.48	56.1	7.91	63.1	8.31
35.2	6.49	42.2	7.02	49.2	7.49	56.2	7.92	63.2	8.31
35.3	6.50	42.3	7.03	49.3	7.50	56.3	7.92	63.3	8.32
35.4	6.51	42.4	7.03	49.4	7.50	56.4	7.93	63.4	8.32
35.5	6.52	42.5	7.04	49.5	7.51	56.5	7.94	63.5	8.33
35.6	6.52	42.6	7.05	49.6	7.52	56.6	7.94	63.6	8.33
35.7	6.53	42.7	7.05	49.7	7.52	56.7	7.95	63.7	8.34
35.8	6.54	42.8	7.06	49.8	7.53	56.8	7.95	63.8	8.34
35.9	6.55	42.9	7.07	49.9	7.53	56.9	7.96	63.9	8.35
36.0	6.56	43.0	7.07	50.0	7.54	57.0	7.97	64.0	8.36

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TABLE 1 *Continued*

Y	V	Y	V	Y	V	Y	V	Y	V
64.1	8.36	71.3	8.73	78.5	9.08	85.7	9.41	92.9	9.72
64.2	8.37	71.4	8.74	78.6	9.09	85.8	9.41	93.0	9.72
64.3	8.37	71.5	8.74	78.7	9.09	85.9	9.42	93.1	9.72
64.4	8.38	71.6	8.75	78.8	9.10	86.0	9.42	93.2	9.73
64.5	8.38	71.7	8.75	78.9	9.10	86.1	9.43	93.3	9.73
64.6	8.39	71.8	8.76	79.0	9.10	86.2	9.43	93.4	9.74
64.7	8.39	71.9	8.76	79.1	9.11	86.3	9.43	93.5	9.74
64.8	8.40	72.0	8.77	79.2	9.11	86.4	9.44	93.6	9.74
64.9	8.40	72.1	8.77	79.3	9.12	86.5	9.44	93.7	9.75
65.0	8.41	72.2	8.78	79.4	9.12	86.6	9.45	93.8	9.75
65.1	8.41	72.3	8.78	79.5	9.13	86.7	9.45	93.9	9.76
65.2	8.42	72.4	8.79	79.6	9.13	86.8	9.46	94.0	9.76
65.3	8.42	72.5	8.79	79.7	9.14	86.9	9.46	94.1	9.76
65.4	8.43	72.6	8.80	79.8	9.14	87.0	9.47	94.2	9.77
65.5	8.44	72.7	8.80	79.9	9.15	87.1	9.47	94.3	9.77
65.6	8.44	72.8	8.81	80.0	9.15	87.2	9.47	94.4	9.78
65.7	8.45	72.9	8.81	80.1	9.16	87.3	9.48	94.5	9.78
65.8	8.45	73.0	8.82	80.2	9.16	87.4	9.48	94.6	9.79
65.9	8.46	73.1	8.82	80.3	9.17	87.5	9.49	94.7	9.79
66.0	8.46	73.2	8.83	80.4	9.17	87.6	9.49	94.8	9.79
66.1	8.47	73.3	8.83	80.5	9.17	87.7	9.50	94.9	9.80
66.2	8.47	73.4	8.84	80.6	9.18	87.8	9.50	95.0	9.80
66.3	8.48	73.5	8.84	80.7	9.18	87.9	9.50	95.1	9.81
66.4	8.48	73.6	8.85	80.8	9.19	88.0	9.51	95.2	9.81
66.5	8.49	73.7	8.85	80.9	9.19	88.1	9.51	95.3	9.81
66.6	8.49	73.8	8.86	81.0	9.20	88.2	9.52	95.4	9.82
66.7	8.50	73.9	8.86	81.1	9.20	88.3	9.52	95.5	9.82
66.8	8.50	74.0	8.87	81.2	9.21	88.4	9.53	95.6	9.83
66.9	8.51	74.1	8.87	81.3	9.21	88.5	9.53	95.7	9.83
67.0	8.51	74.2	8.88	81.4	9.22	88.6	9.53	95.8	9.83
67.1	8.52	74.3	8.88	81.5	9.22	88.7	9.54	95.9	9.84
67.2	8.53	74.4	8.89	81.6	9.22	88.8	9.54	96.0	9.84
67.3	8.53	74.5	8.89	81.7	9.23	88.9	9.55	96.1	9.85
67.4	8.54	74.6	8.90	81.8	9.23	89.0	9.55	96.2	9.85
67.5	8.54	74.7	8.90	81.9	9.24	89.1	9.56	96.3	9.85
67.6	8.55	74.8	8.91	82.0	9.24	89.2	9.56	96.4	9.86
67.7	8.55	74.9	8.91	82.1	9.25	89.3	9.56	96.5	9.86
67.8	8.56	75.0	8.92	82.2	9.25	89.4	9.57	96.6	9.87
67.9	8.56	75.1	8.92	82.3	9.26	89.5	9.57	96.7	9.87
68.0	8.57	75.2	8.93	82.4	9.26	89.6	9.58	96.8	9.87
68.1	8.57	75.3	8.93	82.5	9.27	89.7	9.58	96.9	9.88
68.2	8.58	75.4	8.93	82.6	9.27	89.8	9.59	97.0	9.88
68.3	8.58	75.5	8.94	82.7	9.27	89.9	9.59	97.1	9.89
68.4	8.59	75.6	8.94	82.8	9.28	90.0	9.59	97.2	9.89
68.5	8.59	75.7	8.95	82.9	9.28	90.1	9.60	97.3	9.89
68.6	8.60	75.8	8.95	83.0	9.29	90.2	9.60	97.4	9.90
68.7	8.60	75.9	8.96	83.1	9.29	90.3	9.61	97.5	9.90
68.8	8.61	76.0	8.96	83.2	9.30	90.4	9.61	97.6	9.91
68.9	8.61	76.1	8.97	83.3	9.30	90.5	9.62	97.7	9.91
69.0	8.62	76.2	8.97	83.4	9.31	90.6	9.62	97.8	9.91
69.1	8.62	76.3	8.98	83.5	9.31	90.7	9.62	97.9	9.92
69.2	8.63	76.4	8.98	83.6	9.32	90.8	9.63	98.0	9.92
69.3	8.63	76.5	8.99	83.7	9.32	90.9	9.63	98.1	9.93
69.4	8.64	76.6	8.99	83.8	9.32	91.0	9.64	98.2	9.93
69.5	8.64	76.7	9.00	83.9	9.33	91.1	9.64	98.3	9.93
69.6	8.65	76.8	9.00	84.0	9.33	91.2	9.64	98.4	9.94
69.7	8.65	76.9	9.01	84.1	9.34	91.3	9.65	98.5	9.94
69.8	8.66	77.0	9.01	84.2	9.34	91.4	9.65	98.6	9.95
69.9	8.66	77.1	9.02	84.3	9.35	91.5	9.66	98.7	9.95
70.0	8.67	77.2	9.02	84.4	9.35	91.6	9.66	98.8	9.95
70.1	8.67	77.3	9.03	84.5	9.36	91.7	9.67	98.9	9.96
70.2	8.68	77.4	9.03	84.6	9.36	91.8	9.67	99.0	9.96
70.3	8.68	77.5	9.03	84.7	9.36	91.9	9.67	99.1	9.97
70.4	8.69	77.6	9.04	84.8	9.37	92.0	9.68	99.2	9.97
70.5	8.69	77.7	9.04	84.9	9.37	92.1	9.68	99.3	9.97
70.6	8.70	77.8	9.05	85.0	9.38	92.2	9.69	99.4	9.98
70.7	8.70	77.9	9.05	85.1	9.38	92.3	9.69	99.5	9.98
70.8	8.71	78.0	9.06	85.2	9.39	92.4	9.69	99.6	9.99
70.9	8.71	78.1	9.06	85.3	9.39	92.5	9.70	99.7	9.99
71.0	8.72	78.2	9.07	85.4	9.40	92.6	9.70	99.8	9.99
71.1	8.72	78.3	9.07	85.5	9.40	92.7	9.71	99.9	10.00
71.2	8.73	78.4	9.08	85.6	9.40	92.8	9.71	100.0	10.00

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TABLE 2 The CIE (Y, x, y) Specifications for the Recommended Munsell Notations for 40 Hues (H) and 9 Values (V/) at Every Second Chroma (/C) Step from /2 to the Theoretical Colorant Limits Maximum

		Reds							
Value/ Chroma		2.5R		5.0R		7.5R		10.0R	
(V/C)	Y	x	y	x	y	x	y	x	y
9/6	76.77	0.3665	0.3183	0.3734	0.3256	0.3812	0.3348	0.3880	0.3439
4		0.3445	0.3179	0.3495	0.3226	0.3551	0.3283	0.3600	0.3348
2		0.3210	0.3168	0.3240	0.3188	0.3263	0.3210	0.3284	0.3233
8/10	57.59	0.4125	0.3160	0.4249	0.3270	0.4388	0.3419	0.4490	0.3589
8		0.3900	0.3171	0.4001	0.3263	0.4118	0.3385	0.4212	0.3526
6		0.3671	0.3175	0.3743	0.3248	0.3830	0.3335	0.3910	0.3442
4		0.3460	0.3177	0.3510	0.3224	0.3564	0.3279	0.3621	0.3349
2		0.3236	0.3169	0.3254	0.3186	0.3277	0.3211	0.3301	0.3237
7/16	41.95	0.4885	0.3039			0.5341	0.3452	0.5519	0.3729
14		0.4660	0.3082	0.4848	0.3238	0.5059	0.3450	0.5234	0.3700
12		0.4435	0.3119	0.4595	0.3252	0.4777	0.3435	0.4930	0.3659
10		0.4183	0.3144	0.4320	0.3260	0.4470	0.3413	0.4600	0.3596
8		0.3961	0.3160	0.4067	0.3256	0.4196	0.3382	0.4308	0.3533
6		0.3728	0.3170	0.3805	0.3244	0.3888	0.3336	0.3984	0.3452
4		0.3499	0.3171	0.3552	0.3222	0.3611	0.3282	0.3671	0.3360
2		0.3284	0.3170	0.3306	0.3190	0.3335	0.3220	0.3360	0.3253
6/18	29.31	0.5262	0.2928	0.5552	0.3138	0.5829	0.3396	0.6009	0.3720
16		0.5041	0.2983	0.5297	0.3179	0.5560	0.3420	0.5741	0.3713
14		0.4790	0.3041	0.5020	0.3212	0.5265	0.3431	0.5468	0.3697
12		0.4568	0.3082	0.4760	0.3234	0.4961	0.3428	0.5150	0.3667
10		0.4320	0.3118	0.4480	0.3250	0.4655	0.3412	0.4812	0.3619
8		0.4065	0.3144	0.4187	0.3251	0.4318	0.3383	0.4449	0.3550
6		0.3832	0.3158	0.3921	0.3244	0.4000	0.3340	0.4103	0.3473
4		0.3566	0.3163	0.3628	0.3221	0.3692	0.3291	0.3768	0.3381
2		0.3318	0.3166	0.3343	0.3190	0.3381	0.3228	0.3417	0.3268
5/20	19.24	0.5784	0.2719	0.6142	0.2970	0.6388	0.3216		
18		0.5540	0.2804	0.5918	0.3038	0.6161	0.3277	0.6297	0.3642
16		0.5300	0.2880	0.5637	0.3102	0.5901	0.3331	0.6037	0.3657
14		0.5047	0.2950	0.5341	0.3158	0.5590	0.3370	0.5771	0.3664
12		0.4820	0.3002	0.5071	0.3194	0.5280	0.3389	0.5181	0.3660
10		0.4533	0.3058	0.4747	0.3227	0.4927	0.3399	0.5113	0.3630
8		0.4252	0.3101	0.4413	0.3240	0.4563	0.3387	0.4713	0.3575
6		0.3960	0.3130	0.4078	0.3238	0.4180	0.3348	0.4299	0.3499
4		0.3660	0.3148	0.3740	0.3220	0.3806	0.3294	0.3879	0.3398
2		0.3360	0.3158	0.3392	0.3192	0.3425	0.3229	0.3464	0.3278
4/20	11.71					0.6806	0.2988		
18		0.5898	0.2622	0.6329	0.2881	0.6538	0.3100		
16		0.5620	0.2724	0.6039	0.2978	0.6260	0.3192	0.6409	0.3533
14		0.5369	0.2810	0.5714	0.3057	0.5959	0.3269	0.6154	0.3568
12		0.5072	0.2897	0.5385	0.3129	0.5603	0.3321	0.5801	0.3588
10		0.4774	0.2969	0.5043	0.3176	0.5235	0.3351	0.5418	0.3580
8		0.4472	0.3031	0.4690	0.3209	0.4850	0.3359	0.4995	0.3557
6		0.4141	0.3085	0.4299	0.3226	0.4415	0.3340	0.4535	0.3500
4		0.3800	0.3125	0.3916	0.3223	0.3990	0.3300	0.4078	0.3412
2		0.3461	0.3150	0.3508	0.3200	0.3538	0.3236	0.3582	0.3294
3/16	6.396	0.6116	0.2456	0.6520	0.2660	0.6817	0.2872		
14		0.5828	0.2579	0.6204	0.2789	0.6492	0.3012	0.6703	0.3249
12		0.5536	0.2691	0.5884	0.2904	0.6158	0.3129	0.6322	0.3361
10		0.5191	0.2811	0.5500	0.3024	0.5730	0.3240	0.5871	0.3440
8		0.4821	0.2918	0.5064	0.3114	0.5251	0.3297	0.5393	0.3477
6		0.4409	0.3009	0.4592	0.3168	0.4738	0.3316	0.4854	0.3467
4		0.4021	0.3076	0.4148	0.3190	0.4240	0.3302	0.4308	0.3412
2		0.3591	0.3130	0.3645	0.3190	0.3690	0.3248	0.3728	0.3314

		Yellow-Reds							
		2.5YR		5.0YR		7.5YR		10.0YR	
V/C	Y	x	y	x	y	x	y	x	y
9/8	76.77					0.4220	0.3930	0.4199	0.4069
6		0.3927	0.3550	0.3948	0.3659	0.3950	0.3763	0.3941	0.3877
4		0.3641	0.3422	0.3668	0.3509	0.3679	0.3585	0.3677	0.3668
2		0.3320	0.3273	0.3353	0.3325	0.3380	0.3377	0.3392	0.3430
8/20	57.59					0.5391	0.4518	0.5245	0.4709
18						0.5316	0.4480	0.5179	0.4670
16						0.51.95	0.4424	0.5079	0.4613
14				0.5088	0.4145	0.5025	0.4338	0.4940	0.4530
12		0.4852	0.3847	0.4849	0.4050	0.4816	0.4232	0.4753	0.4414
10		0.4552	0.3761	0.4576	0.3938	0.4568	0.4100	0.4527	0.4268
8		0.4275	0.3662	0.4310	0.3820	0.4306	0.3952	0.4280	0.4102
6		0.3960	0.3547	0.3988	0.3663	0.4000	0.1770	0.3994	0.3896
4		0.3667	0.3429	0.3690	0.3510	0.3699	0.3586	0.3701	0.3674
2		0.3334	0.3276	0.3373	0.3330	0.3395	0.3379	0.3407	0.3434
7/20	41.95	0.5824	0.4046	0.5657	0.4298				
18		0.5695	0.4024	0.5564	0.4267	0.5417	0.4492	0.5276	0.4700
16		0.5522	0.3989	0.5437	0.4228	0.5319	0.4449	0.5188	0.4650
14		0.5297	0.3938	0.5252	0.4168	0.5174	0.4381	0.5074	0.4581
12		0.5001	0.3861	0.5007	0.4081	0.4970	0.4282	0.4900	0.4480
10		0.4671	0.3768	0.4711	0.3972	0.4704	0.4151	0.4667	0.4335
8		0.4371	0.3679	0.4402	0.3842	0.4415	0.3996	0.4399	0.4164
6		0.4053	0.3570	0.4091	0.3701	0.4107	0.3820	0.4102	0.3960
4		0.3715	0.3439	0.3750	0.3530	0.3772	0.3613	0.3778	0.3719
2		0.3392	0.3298	0.3421	0.3349	0.3437	0.3397	0.3443	0.3454
6/18	29.31	0.5879	0.4021	0.5715	0.4270				
16		0.5698	0.3990	0.5597	0.4239	0.5468	0.4478		
14		0.5488	0.3947	0.5423	0.4188	0.5320	0.4412	0.5200	0.4623
12		0.5215	0.3887	0.5199	0.4119	0.5145	0.4331	0.5050	0.4536
10		0.4891	0.3806	0.4921	0.4022	0.4904	0.4220	0.4843	0.4416
8		0.4533	0.3708	0.4592	0.3900	0.4596	0.4064	0.4570	0.4249
6		0.4180	0.3600	0.4229	0.3750	0.4242	0.3876	0.4240	0.4030
4		0.3806	0.3467	0.3840	0.3564	0.3860	0.3652	0.3861	0.3767
2		0.3453	0.3321	0.3474	0.3373	0.3487	0.3421	0.3491	0.3483
5/16	19.24	0.5933	0.3989						
14		0.5731	0.3953	0.5642	0.4201	0.5506	0.4450		
12		0.5482	0.3909	0.5422	0.4141	0.5335	0.4378	0.5211	0.4600
10		0.5175	0.3844	0.5161	0.4064	0.5108	0.4276	0.5025	0.4489
8		0.4795	0.3758	0.4830	0.3960	0.4820	0.4141	0.4770	0.4338
6		0.4365	0.3640	0.4420	0.3808	0.4440	0.3954	0.4428	0.4128
4		0.3925	0.3494	0.3968	0.3614	0.3991	0.3714	0.3995	0.3840
2		0.3506	0.3337	0.3530	0.3395	0.3540	0.3445	0.3546	0.3514
4/12	11.71	0.5809	0.3910	0.5729	0.4169				
10		0.5475	0.3856	0.5432	0.4097	0.5356	0.4342	0.5250	0.4573
8		0.5071	0.3777	0.5070	0.3994	0.5038	0.4204	0.4965	0.4414
6		0.4612	0.3674	0.4651	0.3859	0.4655	0.4029	0.4618	0.4213
4		0.4141	0.3539	0.4187	0.3679	0.4208	0.3809	0.4189	0.3948
2		0.3624	0.3367	0.3651	0.3442	0.3662	0.3504	0.3660	0.3590
3/10	6.396	0.5941	0.3818						
8		0.5475	0.3771	0.5456	0.4040	0.5390	0.4306	0.5305	0.4559
6		0.4954	0.3692	0.4966	0.3908	0.4930	0.4116	0.4872	0.4326
4		0.4360	0.3563	0.4376	0.3715	0.4378	0.3865	0.4341	0.4018
2		0.3757	0.3391	0.3771	0.3476	0.3771	0.3549	0.3747	0.3630

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TABLE 2 *Continued*

		Reds							
		2.5R		5.0R		7.5R		10.0R	
Value/ Chroma (V/C)	Y	x	y	x	y	x	y	x	y
2/14	3.056	0.5734	0.2083	0.6302	0.2287	0.6791	0.2520	0.7165	0.2734
12		0.5438	0.2254	0.5930	0.2465	0.6392	0.2704	0.6732	0.2937
10		0.5122	0.2428	0.5557	0.2633	0.5952	0.2874	0.6247	0.3120
8		0.4776	0.2593	0.5143	0.2800	0.5433	0.3027	0.5713	0.3259
6		0.4390	0.2760	0.4642	0.2934	0.4875	0.3123	0.5095	0.3331
4		0.4021	0.2900	0.4184	0.3032	0.4335	0.3169	0.4481	0.3330
2		0.3614	0.3033	0.3692	0.3111	0.3751	0.3181	0.3811	0.3274
1/10	1.176	0.5058	0.1900	0.5604	0.2100	0.6111	0.2290	0.6661	0.2499
8		0.4812	0.2103	0.5282	0.2297	0.5722	0.2487	0.6178	0.2713
6		0.4515	0.2329	0.4885	0.2515	0.5235	0.2698	0.5584	0.2921
4		0.4166	0.2569	0.4420	0.2728	0.4660	0.2888	0.4933	0.3068
2		0.3768	0.2816	0.3908	0.2929	0.4020	0.3034	0.4128	0.3154

		Yellow-Reds							
		2.5YR		5.0YR		7.5YR		10.0YR	
V/C	Y	x	y	x	y	x	y	x	y
2/8	3.056	0.5995	0.3590						
6		0.5280	0.3581	0.5426	0.3925	0.5475	0.4271		
4		0.4598	0.3508	0.4674	0.3738	0.4690	0.3964	0.4676	0.4168
2		0.3852	0.3365	0.3880	0.3476	0.3889	0.3590	0.3872	0.3688
1/8	1.176	0.6721	0.3058						
6		0.6048	0.3270						
4		0.5311	0.3371	0.5660	0.3795				
2		0.4258	0.3344	0.4377	0.3580	0.4430	0.3775	0.4446	0.3982

		Yellows							
		2.5Y		5.0Y		7.5Y		10.0Y	
V/C	Y	x	y	x	y	x	y	x	y
9/20	76.77			0.4830	0.5092				
18				0.4782	0.5049	0.4663	0.5188	0.4540	0.5320
16				0.4711	0.4977	0.4595	0.5104	0.4477	0.5225
14				0.4602	0.4869	0.4503	0.4993	0.4393	0.5101
12		0.4569	0.4527	0.4455	0.4719	0.4369	0.4829	0.4271	0.4920
10		0.4370	0.4369	0.4275	0.4529	0.4201	0.4622	0.4120	0.4694
8		0.4154	0.4186	0.4080	0.4319	0.4019	0.4392	0.3957	0.4450
6		0.3910	0.3972	0.3858	0.4071	0.3811	0.4123	0.3761	0.4155
4		0.3655	0.3738	0.3621	0.3799	0.3591	0.3832	0.3558	0.3852
2		0.3390	0.3472	0.3378	0.3504	0.3365	0.3527	0.3349	0.3537
8/20	57.59	0.5091	0.4900						
18		0.5033	0.4855	0.4847	0.5069	0.4709	0.5220	0.4570	0.5366
16		0.4957	0.4800	0.4791	0.5012	0.4658	0.5158	0.4525	0.5295
14		0.4842	0.4712	0.4699	0.4920	0.4574	0.5062	0.4450	0.5181
12		0.4678	0.4589	0.4562	0.4788	0.4455	0.4917	0.4341	0.5020
10		0.4469	0.4423	0.4376	0.4601	0.4283	0.4712	0.4190	0.4791
8		0.4231	0.4231	0.4158	0.4378	0.4088	0.4466	0.4008	0.4520
6		0.3969	0.4009	0.3913	0.4117	0.3862	0.4175	0.3803	0.4216
4		0.3684	0.3751	0.3650	0.3826	0.3622	0.3861	0.3581	0.3883
2		0.3406	0.3484	0.3394	0.3518	0.3379	0.3540	0.3359	0.3552
7/16	41.95	0.5049	0.4843	0.4875	0.5047	0.4728	0.5215	0.4582	0.5375
14		0.4950	0.4773	0.4791	0.4965	0.4652	0.5128	0.4516	0.5277
12		0.4806	0.4666	0.4677	0.4857	0.4547	0.5005	0.4420	0.5131
10		0.4606	0.4516	0.4509	0.4696	0.4400	0.4830	0.4289	0.4937
8		0.4353	0.4312	0.4271	0.4462	0.4184	0.4568	0.4090	0.4641
6		0.4073	0.4073	0.4009	0.4198	0.3943	0.4264	0.3864	0.4305
4		0.3761	0.3800	0.3718	0.3885	0.3677	0.3925	0.3624	0.3951
2		0.3436	0.3507	0.3419	0.3540	0.3396	0.3558	0.3369	0.3569
6/14	29.31	0.5061	0.4829	0.4905	0.5038	0.4754	0.5220	0.4593	0.5392
12		0.4928	0.4730	0.4780	0.4920	0.4638	0.5087	0.4488	0.5237
10		0.4760	0.4607	0.4639	0.4790	0.4512	0.4943	0.4372	0.5068
8		0.4517	0.4421	0.4426	0.4588	0.4321	0.4719	0.4201	0.4812
6		0.4203	0.4176	0.4140	0.4305	0.4060	0.4400	0.3960	0.4452
4		0.3840	0.3867	0.3794	0.3955	0.3745	0.4004	0.3679	0.4033
2		0.3480	0.3540	0.3457	0.3580	0.3431	0.3601	0.3398	0.3611

		Green-Yellows							
		2.5GY		5.0GY		7.5GY		10.0GY	
V/C	Y	x	y	x	y	x	y	x	y
9/18	76.77	0.4354	0.5508	0.4108	0.5699	0.3602	0.5920	0.3032	0.5748
16		0.4288	0.5383	0.4058	0.5541	0.3581	0.5654	0.3079	0.5440
14		0.4212	0.5237	0.3993	0.5329	0.3551	0.5339	0.3115	0.5129
12		0.4108	0.5028	0.3911	0.5082	0.3518	0.5042	0.3139	0.4829
10		0.3973	0.4761	0.3810	0.4791	0.3471	0.4735	0.3155	0.4558
8		0.3834	0.4490	0.3698	0.4497	0.3414	0.4415	0.3157	0.4259
6		0.3670	0.4178	0.3572	0.4179	0.3351	0.4111	0.3153	0.4008
4		0.3199	0.3866	0.3437	0.3861	0.3274	0.3793	0.3144	0.3711
2		0.3321	0.3539	0.3284	0.3534	0.3198	0.3500	0.3124	0.3454
8/24	57.59							0.2781	0.6840
22								0.2846	0.6564
20				0.4127	0.5855	0.3592	0.6235	0.2918	0.6255
18		0.4371	0.5557	0.4104	0.5785	0.3585	0.6063	0.2987	0.5919
16		0.4327	0.5475	0.4061	0.5641	0.3569	0.5798	0.3043	0.5578
14		0.4261	0.5344	0.4011	0.5468	0.3546	0.5490	0.3091	0.5247
12		0.4154	0.5133	0.3924	0.5199	0.3511	0.5144	0.3124	0.4926
10		0.4021	0.4869	0.3816	0.4879	0.3463	0.4791	0.3140	0.4601
8		0.3858	0.4550	0.3696	0.4542	0.3408	0.4452	0.3149	0.4284
6		0.3690	0.4230	0.3573	0.4214	0.3220	0.4129	0.3150	0.4014
4		0.3504	0.3887	0.3433	0.3872	0.3266	0.3809	0.3140	0.3727
2		0.3327	0.3555	0.3284	0.3542	0.3194	0.3502	0.3121	0.3459
7/22	41.95							0.2728	0.6893
20								0.2816	0.6563
18						0.3555	0.6242	0.2905	0.6186
16		0.4366	0.5578	0.4076	0.5783	0.3549	0.6000	0.2981	0.5835
14		0.4309	0.5459	0.4027	0.5615	0.3532	0.5700	0.3047	0.5458
12		0.4213	0.5270	0.3949	0.5367	0.3502	0.5328	0.3092	0.5095
10		0.4091	0.5030	0.3852	0.5051	0.3461	0.4950	0.3123	0.4732
8		0.3919	0.4684	0.3722	0.4669	0.3406	0.4558	0.3140	0.4387
6		0.3728	0.4316	0.3581	0.4291	0.3341	0.4191	0.3142	0.4058
4		0.3534	0.3953	0.3437	0.3929	0.3267	0.3848	0.3133	0.3761
2		0.3328	0.3569	0.3284	0.3559	0.3190	0.3516	0.3117	0.3469
6/20	29.31							0.2648	0.7004
18								0.2763	0.6616
16						0.3498	0.6282	0.2872	0.6199
14		0.4354	0.5594	0.4042	0.5788	0.3498	0.5985	0.2962	0.5802
12		0.4269	0.5414	0.3980	0.5564	0.3488	0.5596	0.3037	0.5358
10		0.4159	0.5190	0.3891	0.5264	0.3463	0.5196	0.3086	0.4949
8		0.4006	0.4885	0.3772	0.4880	0.3418	0.4768	0.3116	0.4563
6		0.3799	0.4470	0.3622	0.4438	0.3351	0.4321	0.3128	0.4175
4		0.3572	0.4038	0.3461	0.4008	0.3275	0.3922	0.3124	0.3822
2		0.3342	0.3607	0.3288	0.3592	0.3193	0.3550	0.3112	0.3496

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TABLE 2 *Continued*

		Yellows							
		2.5Y		5.0Y		7.5Y		10.0Y	
V/C	Y	x	y	x	y	x	y	x	y
5/12	19.24	0.5082	0.4812	0.4932	0.5019	0.4767	0.5208	0.4590	0.5390
10		0.4905	0.4683	0.4777	0.4876	0.4632	0.5057	0.4468	0.5209
8		0.4685	0.4524	0.4579	0.4692	0.4450	0.4850	0.4307	0.4967
6		0.4380	0.4292	0.4302	0.4435	0.4199	0.4551	0.4072	0.4621
4		0.3968	0.3954	0.3915	0.4057	0.3850	0.4120	0.3762	0.4158
2		0.3534	0.3570	0.3500	0.3620	0.3470	0.3640	0.3422	0.3648
4/10	11.71	0.5120	0.4800						
8		0.4865	0.4625	0.4745	0.4810	0.4595	0.4990	0.4430	0.5153
6		0.4542	0.4391	0.4451	0.4550	0.4331	0.4688	0.4190	0.4795
4		0.4138	0.4076	0.4069	0.4188	0.3982	0.4272	0.3871	0.4321
2		0.3633	0.3654	0.3590	0.3701	0.3542	0.3727	0.3476	0.3732
3/6	6.396	0.4784	0.4531	0.4670	0.4711	0.4526	0.4889	0.4345	0.5026
4		0.4277	0.4166	0.4191	0.4283	0.4086	0.4379	0.3961	0.4452
2		0.3703	0.3700	0.3646	0.3748	0.3589	0.3778	0.3513	0.3789
2/4	3.056	0.4627	0.4392	0.4543	0.4573	0.4401	0.4723	0.4188	0.4789
2		0.3825	0.3785	0.3757	0.3839	0.3660	0.3858	0.3556	0.3848
1/2	1.176	0.4362	0.4177	0.4230	0.4265	0.4042	0.4287	0.3802	0.4212

		Green-Yellows							
		2.5GY		5.0GY		7.5GY		10.0GY	
V/C	Y	x	y	x	y	x	y	x	y
5/18	19.24							0.2549	0.7179
16								0.2702	0.6700
14						0.3429	0.6335	0.2838	0.6208
12		0.4333	0.5602	0.4011	0.5802	0.3450	0.5949	0.2940	0.5751
10		0.4224	0.5369	0.3928	0.5485	0.3451	0.5490	0.3028	0.5237
8		0.4088	0.5068	0.3815	0.5093	0.3412	0.4976	0.3080	0.4759
6		0.3879	0.4646	0.3663	0.4614	0.3354	0.4483	0.3108	0.4301
4		0.3621	0.4143	0.3482	0.4097	0.3274	0.3994	0.3111	0.3881
2		0.3352	0.3636	0.3289	0.3612	0.3188	0.3560	0.3110	0.3508
4/16	11.71							0.2422	0.7360
14								0.2590	0.6858
12						0.3348	0.6468	0.2758	0.6282
10						0.3395	0.5913	0.2908	0.5672
8		0.4174	0.5300	0.3868	0.5384	0.3400	05348	0.3008	0.5095
6		0.3968	0.4857	0.3718	0.4852	0.3355	0.4739	0.3069	0.4550
4		0.3708	0.4329	0.3538	0.4284	0.3281	0.4157	0.3100	0.4018
2		0.3382	0.3706	0.3312	0.3678	0.3185	0.3604	0.3109	0.3550
3/14	6.396							0.2283	0.7423
12								0.2531	0.6700
10						0.3266	0.6448	0.2724	0.6026
8				0.3924	0.5832	0.3341	0.5700	0.2887	0.5361
6		0.4069	0.5110	0.3750	0.5109	0.3333	0.4967	0.2992	0.4717
4		0.3772	0.4484	0.3554	0.4429	0.3270	0.4288	0.3053	0.4123
2		0.3412	0.3768	0.3319	0.3729	0.3180	0.3644	0.3088	0.3578
2/12	3.056							0.1907	0.7798
10								0.2307	0.6814
8						0.3160	0.6509	0.2628	0.5837
6				0.3839	0.5748	0.3260	0.5379	0.2852	0.4972
4		0.3881	0.4752	0.3582	0.4650	0.3248	0.4457	0.2986	0.4240
2		0.3421	0.3803	0.3309	0.3743	0.3165	0.3650	0.3069	0.3580
1/6	1.176							0.2232	0.6392
4				0.3765	0.5942	0.3133	0.5380	0.2722	0.4903
2		0.3540	0.4088	0.3359	0.3982	0.3154	0.3840	0.3006	0.3720

		Greens							
		2.5G		5.0G		7.0G		10.0G	
V/C	Y	x	y	x	y	x	y	x	y
9/16	76.77	0.2630	0.4966						
14		0.2711	0.4726						
12		0.2786	0.4491	0.2528	0.4160	0.2419	0.3985	0.2325	0.3796
10		0.2851	0.4275	0.2634	0.4001	0.2545	0.3855	0.2457	0.3702
8		0.2912	0.4054	0.2735	0.3854	0.2652	0.3738	0.2574	0.3618
6		0.2966	0.3846	0.2832	0.3697	0.2763	0.3607	0.2703	0.3513
4		0.3018	0.3606	0.2933	0.3519	0.2882	0.3461	0.2840	0.3402
2		0.3058	0.3400	0.3017	0.3357	0.2987	0.3323	0.2964	0.3293
8/24	57.59	0.2091	0.6033						
22		0.2221	0.5799	0.1821	0.4940				
20		0.2339	0.5561	0.1956	0.4806	0.1845	0.4492	0.1734	0.4164
18		0.2451	0.5309	0.2103	0.4652	0.2980	0.4372	0.1866	0.4086
16		0.2563	0.5045	0.2240	0.4500	0.2120	0.4252	0.2012	0.3992
14		0.2661	0.4780	0.2368	0.4348	0.2254	0.4125	0.2148	0.3903
12		0.2743	0.4554	0.2489	0.4191	0.2380	0.4002	0.2282	0.3811
10		0.2829	0.4301	0.2613	0.4026	0.2515	0.3867	0.2430	0.3710
8		0.2896	0.4065	0.2723	0.3865	0.2639	0.3733	0.2564	0.3611
6		0.2952	0.3851	0.2822	0.3702	0.2754	0.3608	0.2693	0.3512
4		0.3009	0.3614	0.2924	0.3523	0.2874	0.3464	0.2828	0.3403
2		0.3053	0.3404	0.3009	0.3359	0.2981	0.3326	0.2957	0.3293

		Blue-Greens							
		2.5BG		5.0BG		7.5BG		10.0BG	
V/C	Y	x	y	x	y	x	y	x	y
9/10	76.77	0.2382	0.3568	0.2301	0.3405	0.2215	0.3226		
8		0.2509	0.3507	0.2437	0.3378	0.2361	0.3225		
6		0.2652	0.3433	0.2599	0.3338	0.2543	0.3220	0.2501	0.3118
4		0.2805	0.3349	0.2768	0.3287	0.2728	0.3208	0.2700	0.3140
2		0.2947	0.3267	0.2930	0.3232	0.2911	0.3188	0.2907	0.3159
8/18	57.59	0.1759	0.3782						
16		0.1915	0.3732	0.1814	0.3450	0.1721	0.3168		
14		0.2057	0.3681	0.1958	0.3432	0.1868	0.3179	0.1788	0.2936
12		0.2196	0.3630	0.2101	0.3412	0.2010	0.3188	0.1937	0.2978
10		0.2352	0.3566	0.2264	0.3383	0.2184	0.3196	0.2120	0.3025
8		0.2500	0.3500	0.2419	0.3352	0.2352	0.3198	0.2302	0.3063
6		0.2647	0.3429	0.2588	0.3318	0.2525	0.3198	0.2489	0.3099
4		0.2791	0.3351	0.2752	0.3278	0.2718	0.3200	0.2686	0.3130
2		0.2940	0.3268	0.2919	0.3228	0.2900	0.3183	0.2894	0.3152

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TABLE 2 *Continued*

		Greens							
		2.5G		5.0G		7.0G		10.0G	
V/C	*Y*	*x*	*y*	*x*	*y*	*x*	*y*	*x*	*y*
7/26	41.95	0.1689	0.6549	0.1397	0.5312	0.1303	0.4858		
24		0.1875	0.6265	0.1521	0.3200	0.1415	0.4778	0.1310	0.4377
22		0.2029	0.6017	0.1659	0.5074	0.1539	0.4683	0.1434	0.4306
20		0.2181	0.5714	0.1805	0.4933	0.1688	0.4570	0.1589	0.4220
18		0.2328	0.5467	0.1967	0.4771	0.1841	0.4448	0.1734	0.4135
16		0.2448	0.5203	0.2111	0.4616	0.1982	0.4330	0.1881	0.4049
14		0.2568	0.4931	0.2262	0.4130	0.2139	0.4199	0.2033	0.3956
12		0.2672	0.4667	0.2416	0.4267	0.2295	0.4058	0.2195	0.3854
10		0.2775	0.4395	0.2554	0.4087	0.2445	0.3914	0.2352	0.3748
8		0.2861	0.4129	0.2687	0.3901	0.2595	0.3764	0.2513	0.3635
6		0.2933	0.3873	0.2801	0.3721	0.2728	0.3622	0.2662	0.3526
4		0.2992	0.3644	0.2902	0.3548	0.2850	0.3482	0.2803	0.3415
2		0.3047	0.3413	0.3001	0.3366	0.2972	0.3333	0.2945	0.3297
6/28	29.31	0.1145	0.7122	0.0908	0.5695	0.0858	0.5127		
26		0.1340	0.6871	0.1079	0.5560	0.1010	0.5018	0.0941	0.4520
24		0.1536	0.6605	0.1252	0.5408	0.1159	0.4910	0.1070	0.4458
22		0.1739	0.6318	0.1432	0.5252	0.1325	0.4795	0.1230	0.4378
20		0.1922	0.6035	0.1609	0.5091	0.1485	0.4677	0.1382	0.4299
18		0.2102	0.5737	0.1785	0.4924	0.1654	0.4551	0.1551	0.4208
16		0.2278	0.5430	0.1960	0.4751	0.1832	0.4414	0.1722	0.4113
14		0.2426	0.5133	0.2130	0.4571	0.2001	0.4278	0.1895	0.4015
12		0.2574	0.4814	0.2293	0.4390	0.2171	0.4138	0.2060	0.3914
10		0.2690	0.4530	0.2466	0.4181	0.2350	0.3979	0.2247	0.3796
8		0.2799	0.4239	0.2612	0.3990	0.2510	0.3829	0.2420	0.3679
6		0.2892	0.3963	0.2748	0.3795	0.2662	0.3672	0.2591	0.3558
4		0.2967	0.3695	0.2868	0.3595	0.2807	0.3522	0.2749	0.3443
2		0.3039	0.3437	0.2988	0.3382	0.2958	0.3344	0.2929	0.3303
5/28	19.24	0.0794	0.7385	0.0609	0.5898	0.0585	0.5224	0.0572	0.4590
26		0.0992	0.7155	0.0784	0.5761	0.0730	0.5131	0.0690	0.4542
24		0.1188	0.6918	0.0953	0.5628	0.0878	0.5039	0.0811	0.4491
22		0.1377	0.6674	0.1144	0.5463	0.1050	0.4927	0.0958	0.4428
20		0.1579	0.6392	0.1318	0.5321	0.1212	0.4817	0.1120	0.4360
18		0.1782	0.6095	0.1489	0.5171	0.1372	0.4705	0.1275	0.4288
16		0.2005	0.5759	0.1695	0.4981	0.1571	0.4561	0.1469	0.4192
14		0.2211	0.5411	0.1912	0.4773	0.1776	0.4415	0.1671	0.4089
12		0.2385	0.5071	0.2104	0.4578	0.1964	0.4271	0.1852	0.3992
10		0.2565	0.4705	0.2329	0.4331	0.2200	0.4082	0.2095	0.3853
8		0.2710	0.4380	0.2511	0.4107	0.2395	0.3915	0.2297	0.3730
6		0.2841	0.4045	0.2690	0.3860	0.2598	0.3724	0.2519	0.3587
4		0.2943	0.3735	0.2841	0.3628	0.2775	0.3545	0.2711	0.3455
2		0.3030	0.3445	0.2978	0.3392	0.2945	0.3355	0.2910	0.3310
4/26	11.71	0.0528	0.7502	0.0407	0.6010	0.0392	0.5258	0.0400	0.4545
24		0.0760	0.7250	0.0614	0.5857	0.0581	0.5151	0.0553	0.4492
22		0.1009	0.6975	0.0841	0.5684	0.0770	0.5040	0.0702	0.4440
20		0.1230	0.6706	0.1018	0.5543	0.0928	0.4942	0.0850	0.4388
18		0.1446	0.6431	0.1188	0.5400	0.1086	0.4842	0.1006	0.4330
16		0.1682	0.6111	0.1402	0.5214	0.1293	0.4703	0.1212	0.4245
14		0.1909	0.5779	0.1627	0.5015	0.1500	0.4562	0.1398	0.4168
12		0.2128	0.5425	0.1843	0.4807	0.1706	0.4419	0.1602	0.4070
10		0.2355	0.5006	0.2115	0.4532	0.1989	0.4219	0.1876	0.3933
8		0.2561	0.4597	0.2359	0.4266	0.2232	0.4022	0.2124	0.3799
6		0.2735	0.4215	0.2581	0.3992	0.2467	0.3822	0.2374	0.3655
4		0.2891	0.3821	0.2781	0.3704	0.2702	0.3602	0.2628	0.3498
2		0.3012	0.3470	0.2959	0.3417	0.2919	0.3371	0.2880	0.3327
3/22	6.396	0.0390	0.7468	0.0340	0.6011	0.0332	0.5206	0.0333	0.4444
20		0.0720	0.7127	0.0620	0.5802	0.0568	0.5082	0.0528	0.4393
18		0.1049	0.6766	0.0882	0.5605	0.0798	0.4954	0.0718	0.4340
16		0.1341	0.6420	0.1120	0.5414	0.1023	0.4818	0.0925	0.4275
14		0.1626	0.6052	0.1382	0.5197	0.1262	0.4667	0.1161	0.4192
12		0.1902	0.5642	0.1660	0.4948	0.1516	0.4505	0.1411	0.4095
10		0.2170	0.5211	0.1935	0.4682	0.1800	0.4310	0.1688	0.3974
8		0.2435	0.4752	0.2228	0.4380	0.2088	0.4101	0.1970	0.3841
6		0.2642	0.4342	0.2471	0.4100	0.2346	0.3901	0.2240	0.3699
4		0.2836	0.3915	0.2711	0.3780	0.2618	0.3667	0.2525	0.3537
2		0.2999	0.3500	0.2935	0.3439	0.2890	0.3391	0.2844	0.3337

		Blue-Greens							
		2.5BG		5.0BG		7.5BG		10.0BG	
V/C	*Y*	*x*	*y*	*x*	*y*	*x*	*y*	*x*	*y*
7/22	41.95	0.1334	0.3870						
20		0.1490	0.3827	0.1380	0.3412				
18		0.1626	0.3788	0.1515	0.3410	0.1427	0.3076		
16		0.1788	0.3739	0.1675	0.3401	0.1584	0.3101	0.1489	0.2768
14		0.1932	0.3694	0.1838	0.3390	0.1751	0.3129	0.1671	0.2832
12		0.2102	0.3636	0.1997	0.3379	0.1914	0.3148	0.1841	0.2892
10		0.2264	0.3576	0.2163	0.3361	0.2094	0.3165	0.2035	0.2956
8		0.2439	0.3508	0.2354	0.3335	0.2292	0.3178	0.2235	0.3014
6		0.2608	0.3430	0.2543	0.3302	0.2490	0.3186	0.2448	0.3069
4		0.2764	0.3354	0.2712	0.3269	0.2671	0.3189	0.2642	0.3109
2		0.2927	0.3269	0.2898	0.3225	0.2878	0.3182	0.2869	0.3143
6/22	29.31	0.1120	0.3860						
20		0.1269	0.3829	0.1168	0.3344				
18		0.1428	0.3790	0.1325	0.3345	0.1248	0.2981	0.1181	0.2581
16		0.1600	0.3748	0.1491	0.3345	0.1408	0.3017	0.1337	0.2651
14		0.1779	0.3699	0.1662	0.3343	0.1585	0.3052	0.1518	0.2729
12		0.1954	0.3645	0.1844	0.3337	0.1762	0.3081	0.1698	0.2802
10		0.2148	0.3584	0.2037	0.3329	0.1961	0.3110	0.1909	0.2881
8		0.2332	0.3522	0.2236	0.3311	0.2171	0.3138	0.2116	0.2950
6		0.2526	0.3448	0.2441	0.3290	0.2384	0.3155	0.2335	0.3015
4		0.2702	0.3369	0.2648	0.3262	0.2604	0.3169	0.2578	0.3078
2		0.2902	0.3268	0.2872	0.3219	0.2849	0.3172	0.2837	0.3132
5/24	19.24	0.0738	0.3851						
22		0.0861	0.3832	0.0781	0.3211				
20		0.1005	0.3814	0.0904	0.3231				
18		0.1165	0.3785	0.1046	0.3244	0.0982	0.2828		
16		0.1348	0.3750	0.1243	0.3261	0.1167	0.2880	0.1108	0.2489
14		0.1559	0.3708	0.1448	0.3275	0.1364	0.2932	0.1308	0.2582
12		0.1735	0.3668	0.1614	0.3280	0.1537	0.2976	0.1485	0.2662
10		0.1980	0.3606	0.1850	0.3280	0.1776	0.3032	0.1716	0.2760
8		0.2205	0.3537	0.2100	0.3280	0.2030	0.3082	0.1970	0.2860
6		0.2448	0.3452	0.2360	0.3270	0.2292	0.3125	0.2234	0.2952
4		0.2659	0.3369	0.2591	0.3246	0.2550	0.3150	0.2512	0.3040
2		0.2880	0.3270	0.2841	0.3210	0.2812	0.3161	0.2796	0.3111
4/24	11.71	0.0510	0.3800						
22		0.0636	0.3788						
20		0.0768	0.3773	0.0675	0.3075				
18		0.0915	0.3754	0.0828	0.3108	0.0768	0.2667		
16		0.1102	0.3720	0.0992	0.3141	0.0922	0.2718	0.0888	0.2298
14		0.1283	0.3688	0.1170	0.3170	0.1092	0.2774	0.1033	0.2376
12		0.1492	0.3649	0.1379	0.3198	0.1298	0.2840	0.1248	0.2484
10		0.1738	0.3600	0.1618	0.3219	0.1540	0.2910	0.1480	0.2600
8		0.2006	0.3540	0.1890	0.3234	0.1815	0.2985	0.1760	0.2730
6		0.2278	0.3463	0.2182	0.3240	0.2113	0.3052	0.2065	0.2863
4		0.2552	0.3375	0.2480	0.3232	0.2429	0.3108	0.2384	0.2984
2		0.2840	0.3270	0.2799	0.3208	0.2764	0.3148	0.2740	0.3091
3/20	6.396	0.0482	0.3695						
18		0.0648	0.3682	0.0580	0.2940				
16		0.0843	0.3667	0.0735	0.2979	0.0691	0.2559		
14		0.1051	0.3648	0.0940	0.3027	0.0874	0.2627	0.0798	0.2151
12		0.1288	0.3620	0.1158	0.3071	0.1086	0.2706	0.1018	0.2281
10		0.1552	0.3580	0.1410	0.3118	0.1326	0.2784	0.1250	0.2411
8		0.1845	0.3531	0.1703	0.3159	0.1620	0.2872	0.1551	0.2571
6		0.2132	0.3468	0.2020	0.3188	0.1928	0.2958	0.1861	0.2722
4		0.2437	0.3386	0.2343	0.3200	0.2272	0.3041	0.2221	0.2886
2		0.2799	0.3271	0.2742	0.3192	0.2699	0.3120	0.2660	0.3050

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TABLE 2 *Continued*

		Greens							
		2.5G		5.0G		7.0G		10.0G	
V/C	*Y*	*x*	*y*	*x*	*y*	*x*	*y*	*x*	*y*
2/16	3.056	0.0329	0.7358	0.0277	0.5986	0.0276	0.5153	0.0285	0.4327
14		0.0820	0.6860	0.0688	0.5691	0.0629	0.4973	0.0599	0.4270
12		0.1307	0.6308	0.1120	0.5358	0.1022	0.4759	0.0934	0.4183
10		0.1773	0.5698	0.1560	0.4981	0.1442	0.4505	0.1321	0.4059
8		0.2192	0.5042	0.1979	0.4583	0.1842	0.4244	0.1705	0.3911
6		0.2493	0.4522	0.2318	0.4231	0.2200	0.3983	0.2092	0.3739
4		0.2763	0.3998	0.2640	0.3845	0.2540	0.3705	0.2442	0.3559
2		0.2978	0.3507	0.2918	0.3450	0.2869	0.3400	0.2820	0.3341
1/8	1.176	0.0620	0.6896	0.0559	0.5710	0.0530	0.4943	0.0511	0.4158
6		0.1711	0.5619	0.1468	0.4996	0.1344	0.4505	0.1249	0.4019
4		0.2454	0.4489	0.2290	0.4218	0.2159	0.3967	0.2040	0.3724
2		0.2910	0.3634	0.2833	0.3564	0.2758	0.3484	0.2689	0.3407

		Blue-Greens							
		2.5BG		5.0BG		7.5BG		10.0BG	
V/C	*Y*	*x*	*y*	*x*	*y*	*x*	*y*	*x*	*y*
2/14	3.056	0.0555	0.3588						
12		0.0851	0.3576	0.0769	0.2880	0.0724	0.2478		
10		0.1190	0.3551	0.1050	0.2956	0.0991	0.2582	0.0929	0.2133
8		0.1557	0.3517	0.1405	0.3037	0.1325	0.2710	0.1258	0.2331
6		0.1971	0.3452	0.1843	0.3110	0.1747	0.2853	0.1669	0.2570
4		0.2343	0.3378	0.2234	0.3150	0.2162	0.2981	0.2096	0.2790
2		0.2765	0.3271	0.2697	0.3175	0.2651	0.3096	0.2606	0.3010
1/8	1.176	0.0476	0.3458						
6		0.1169	0.3452	0.1093	0.2860	0.1059	0.2485	0.1074	0.2129
4		0.1883	0.3406	0.1753	0.3021	0.1702	0.2768	0.1658	0.2496
2		0.2600	0.3289	0.2500	0.3141	0.2430	0.3023	0.2362	0.2882

		Blues							
		2.5B		5.0B		7.5B		10.0B	
V/C	*Y*	*x*	*y*	*x*	*y*	*x*	*y*	*x*	*y*
9/4	76.77	0.2680	0.3073	0.2675	0.3005	0.2688	0.2961	0.2712	0.2924
2		0.2909	0.3125	0.2919	0.3102	0.2937	0.3087	0.2949	0.3076
8/12	57.59	0.1877	0.2752						
10		0.2066	0.2839						
8		0.2264	0.2923	0.2237	0.2761	0.2252	0.2668	0.2294	0.2587
6		0.2462	0.3000	0.2457	0.2888	0.2472	0.2821	0.2512	0.2760
4		0.2668	0.3067	0.2671	0.2998	0.2688	0.2956	0.2718	0.2911
2		0.2897	0.3124	0.2908	0.3096	0.2922	0.3077	0.2935	0.3062
7/16	41.95	0.1435	0.2472						
14		0.1624	0.2581	0.1615	0.2307				
12		0.1797	0.2672	0.1778	0.2430	0.1818	0.2303	0.1883	0.2203
10		0.1994	0.2775	0.1986	0.2579	0.2016	0.2466	0.2078	0.2382
8		0.2208	0.2871	0.2204	0.2729	0.2225	0.2631	0.2277	0.2559
6		0.2418	0.2960	0.2410	0.2854	0.2436	0.2787	0.2478	0.2728
4		0.2629	0.3038	0.2633	0.2972	0.2651	0.2927	0.2685	0.2886
2		0.2867	0.3110	0.2875	0.3078	0.2888	0.3058	0.2908	0.3039
6/16	29.31	0.1294	0.2348	0.1310	0.2048	0.1376	0.1879	0.1454	0.1778
14		0.1480	0.2459	0.1496	0.2193	0.1556	0.2043	0.1629	0.1947
12		0.1660	0.2561	0.1685	0.2339	0.1734	0.2203	0.1803	0.2114
10		0.1879	0.2682	0.1883	0.2487	0.1934	0.2374	0.2000	0.2298
8		0.2080	0.2789	0.2088	0.2635	0.2132	0.2537	0.2189	0.2468
6		0.2312	0.2899	0.2320	0.2789	0.2352	0.2708	0.2399	0.2650
4		0.2571	0.3008	0.2579	0.2938	0.2602	0.2881	0.2637	0.2840
2		0.2835	0.3097	0.2842	0.3063	0.2854	0.3037	0.2871	0.3012
5/18	19.24							0.1203	0.1505
16		0.1090	0.2166	0.1132	0.1863	0.1230	0.1711	0.1326	0.1632
14		0.1283	0.2292	0.1320	0.2021	0.1404	0.1878	0.1492	0.1797
12		0.1461	0.2406	0.1505	0.2172	0.1584	0.2042	0.1666	0.1964
10		0.1697	0.2549	0.1729	0.2347	0.1792	0.2230	0.1860	0.2149
8		0.1947	0.2687	0.1958	0.2519	0.2007	0.2417	0.2067	0.2344
6		0.2210	0.2823	0.2215	0.2701	0.2248	0.2612	0.2299	0.2548
4		0.2492	0.2954	0.2493	0.2879	0.2511	0.2808	0.2547	0.2757
2		0.2791	0.3071	0.2794	0.3032	0.2803	0.3000	0.2821	0.2966

		Purple-Blues							
		2.5PB		5.0PB		7.5PB		10.0PB	
V/C	*Y*	*x*	*y*	*x*	*y*	*x*	*y*	*x*	*y*
9/4	76.77							0.2910	0.2850
2		0.2975	0.3063	0.2991	0.3057	0.3015	0.3052	0.3038	0.3054
8/8	57.59							0.2677	0.2443
6		0.2562	0.2709	0.2614	0.2670	0.2702	0.2648	0.2792	0.2649
4		0.2758	0.2879	0.2798	0.2861	0.2856	0.2846	0.2911	0.2848
2		0.2957	0.3047	0.2974	0.3039	0.3003	0.3034	0.3027	0.3035
7/12	41.95							0.2465	0.2058
10		0.2162	0.2309	0.2254	0.2267	0.2410	0.2224	0.2563	0.2240
8		0.2352	0.2498	0.2427	0.2458	0.2546	0.2418	0.2670	0.2425
6		0.2538	0.2677	0.2596	0.2643	0.2687	0.2612	0.2776	0.2612
4		0.2729	0.2848	0.2773	0.2828	0.2833	0.2809	0.2886	0.2801
2		0.2932	0.3025	0.2952	0.3011	0.2982	0.3003	0.3005	0.3000
6/16	29.31							0.2265	0.1671
14		0.1754	0.1868	0.1873	0.1822	0.2119	0.1799	0.2352	0.1839
12		0.1913	0.2038	0.2026	0.1999	0.2241	0.1975	0.2440	0.1998
10		0.2095	0.2225	0.2197	0.2188	0.2378	0.2168	0.2540	0.2176
8		0.2274	0.2406	0.2360	0.2365	0.2505	0.2347	0.2637	0.2352
6		0.2465	0.2599	0.2533	0.2558	0.2638	0.2531	0.2740	0.2533
4		0.2684	0.2804	0.2734	0.2778	0.2798	0.2752	0.2863	0.2747
2		0.2897	0.2991	0.2923	0.2978	0.2955	0.2963	0.2988	0.2961
5/22	19.24							0.2082	0.1225
20						0.1794	0.1239	0.2121	0.1329
18		0.1363	0.1410	0.1518	0.1365	0.1862	0.1365	0.2174	0.1444
16		0.1495	0.1559	0.1638	0.1521	0.1945	0.1511	0.2224	0.1555
14		0.1642	0.1728	0.1773	0.1689	0.2042	0.1661	0.2299	0.1698
12		0.1793	0.1894	0.1918	0.1858	0.2157	0.1830	0.2384	0.1857
10		0.1968	0.2078	0.2080	0.2041	0.2285	0.2020	0.2478	0.2030
8		0.2157	0.2278	0.2255	0.2239	0.2417	0.2204	0.2572	0.2211
6		0.2365	0.2488	0.2447	0.2449	0.2563	0.2417	0.2686	0.2412
4		0.2600	0.2720	0.2662	0.2687	0.2739	0.2666	0.2821	0.2659
2		0.2847	0.2942	0.2882	0.2923	0.2918	0.2908	0.2959	0.2905

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TABLE 2 *Continued*

		Blues							
		2.5B		5.0B		7.5B		10.0B	
V/C	*Y*	*x*	*y*	*x*	*y*	*x*	*y*	*x*	*y*
4/16	11.71	0.0900	0.1973					0.1155	0.1416
14		0.1027	0.2057	0.1098	0.1785	0.1204	0.1655	0.1310	0.1580
12		0.1247	0.2209	0.1299	0.1963	0.1393	0.1837	0.1487	0.1760
10		0.1463	0.2354	0.1512	0.2148	0.1601	0.2028	0.1681	0.1954
8		0.1737	0.2524	0.1759	0.2345	0.1821	0.2232	0.1893	0.2160
6		0.2048	0.2708	0.2060	0.2572	0.2102	0.2470	0.2157	0.2407
4		0.2360	0.2872	0.2363	0.2782	0.2368	0.2704	0.2429	0.2648
2		0.2727	0.3038	0.2723	0.2992	0.2733	0.2947	0.2753	0.2910
3/14	6.396							0.1065	0.1285
12		0.0989	0.1963	0.1042	0.1681	0.1131	0.1542	0.1228	0.1460
10		0.1220	0.2132	0.1259	0.1879	0.1343	0.1756	0.1432	0.1675
8		0.1511	0.2331	0.1527	0.2119	0.1583	0.1987	0.1658	0.1905
6		0.1826	0.2536	0.1835	0.2375	0.1875	0.2258	0.1933	0.2173
4		0.2183	0.2748	0.2176	0.2632	0.2200	0.2536	0.2246	0.2467
2		0.2636	0.2983	0.2617	0.2921	0.2616	0.2857	0.2631	0.2801
2/10	3.056	0.0911	0.1828	0.0965	0.1558	0.1051	0.1422	0.1157	0.1346
8		0.1230	0.2076	0.1245	0.1827	0.1313	0.1692	0.1396	0.1603
6		0.1621	0.2358	0.1617	0.2162	0.1658	0.2026	0.1716	0.1937
4		0.2060	0.2649	0.2048	0.2518	0.2063	0.2400	0.2102	0.2313
2		0.2578	0.2940	0.2559	0.2874	0.2545	0.2799	0.2558	0.2725

		Purple-Blues							
		2.5PB		5.0PB		7.5PB		10.0PB	
V/C	*Y*	*x*	*y*	*x*	*y*	*x*	*y*	*x*	*y*
4/30	11.71							0.1952	0.0778
28								0.1971	0.0840
26						0.1659	0.0825	0.1994	0.0904
24						0.1684	0.0899	0.2020	0.0985
22						0.1713	0.0980	0.2048	0.1064
20				0.1288	0.1027	0.1742	0.1058	0.2075	0.1140
18		0.1218	0.1208	0.1392	0.1167	0.1798	0.1185	0.2120	0.1256
16		0.1336	0.1349	0.1504	0.1317	0.1861	0.1316	0.2170	0.1373
14		0.1473	0.1513	0.1627	0.1479	0.1941	0.1468	0.2220	0.1503
12		0.1634	0.1698	0.1773	0.1659	0.2037	0.1629	0.2298	0.1659
10		0.1805	0.1888	0.1925	0.1843	0.2158	0.1811	0.2388	0.1837
8		0.1995	0.2094	0.2103	0.2050	0.2304	0.2023	0.2497	0.2038
6		0.2235	0.2343	0.2325	0.2300	0.2471	0.2266	0.2618	0.2263
4		0.2487	0.2597	0.2562	0.2560	0.2657	0.2528	0.2759	0.2522
2		0.2782	0.2876	0.2816	0.2842	0.2861	0.2819	0.2911	0.2804
3/34	6.396					0.1608	0.0480	0.1918	0.0503
32						0.1612	0.0511	0.1926	0.0542
30						0.1621	0.0556	0.1938	0.0599
28						0.1632	0.0609	0.1950	0.0650
26						0.1642	0.0655	0.1963	0.0708
24						0.1658	0.0711	0.0982	0.0772
22						0.1677	0.0782	0.2004	0.0847
20						0.1702	0.0867	0.2030	0.0930
18				0.1228	0.0895	0.1730	0.0948	0.2060	0.1020
16				0.1318	0.1024	0.1765	0.1048	0.2092	0.1118
14		0.1251	0.1218	0.1431	0.1184	0.1824	0.1188	0.2142	0.1250
12		0.1398	0.1395	0.1557	0.1356	0.1903	0.1353	0.2206	0.1407
10		0.1576	0.1600	0.1718	0.1562	0.2005	0.1536	0.2278	0.1565
8		0.1780	0.1833	0.1908	0.1799	0.2149	0.1761	0.2387	0.1786
6		0.2022	0.2101	0.2122	0.2052	0.2311	0.2010	0.2511	0.2031
4		0.2312	0.2405	0.2393	0.2361	0.2520	0.2319	0.2660	0.2319
2		0.2663	0.2756	0.2708	0.2719	0.2777	0.2687	0.2847	0.2670
2/38	3.056					0.1623	0.0280		
36						0.1628	0.0310		
34						0.1630	0.0340	0.1911	0.0344
32						0.1635	0.0373	0.1918	0.0379
30						0.1640	0.0409	0.1925	0.0420
28						0.1647	0.0451	0.1937	0.0471
26						0.1653	0.0492	0.1949	0.0520
24						0.1660	0.0538	0.1962	0.0578
22						0.1670	0.0594	0.1978	0.0643
20						0.1685	0.0666	0.1998	0.0718
18						0.1701	0.0742	0.2021	0.0808
16						0.1728	0.0839	0.2052	0.0910
14				0.1253	0.0873	0.1762	0.0955	0.2087	0.1026
12		0.1166	0.1076	0.1363	0.1048	0.1813	0.1094	0.2139	0.1170
10		0.1332	0.1278	0.1500	0.1240	0.1882	0.1258	0.2200	0.1330
8		0.1540	0.1530	0.1685	0.1491	0.2005	0.1495	0.2294	0.1551
6		0.1825	0.1857	0.1942	0.1811	0.2189	0.1790	0.2440	0.1840
4		0.2175	0.2245	0.2263	0.2192	0.2420	0.2148	0.2600	0.2162
2		0.2592	0.2675	0.2638	0.2624	0.2712	0.2582	0.2803	0.2567

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TABLE 2 *Continued*

		Blues							
		2.5B		5.0B		7.5B		10.0B	
V/C	*Y*	*x*	*y*	*x*	*y*	*x*	*y*	*x*	*y*
1/8	1.176					0.0968	0.1280	0.1077	0.1218
6		0.1118	0.1908	0.1212	0.1745	0.1303	0.1639	0.1392	0.1563
4		0.1649	0.2324	0.1667	0.2168	0.1716	0.2048	0.1783	0.1974
2		0.2322	0.2781	0.2291	0.2677	0.2291	0.2579	0.2309	0.2491

		Purple-Blues							
		2.5PB		5.0PB		7.5PB		10.0PB	
V/C	*Y*	*x*	*y*	*x*	*y*	*x*	*y*	*x*	*y*
1/38	1.176					0.1680	0.0140		
36						0.1681	0.0160		
34						0.1682	0.0180		
32						0.1682	0.0202		
30						0.1684	0.0234	0.1928	0.0240
28						0.1686	0.0270	0.1936	0.0281
26						0.1689	0.0309	0.1942	0.0326
24						0.1691	0.0352	0.1952	0.0380
22						0.1696	0.0402	0.1965	0.0436
20						0.1701	0.0454	0.1976	0.0493
18						0.1709	0.0518	0.1991	0.0564
16						0.1720	0.0583	0.2008	0.0638
14						0.1738	0.0688	0.2038	0.0745
12						0.1763	0.0804	0.2070	0.0869
10				0.1285	0.0870	0.1804	0.0950	0.2120	0.1029
8		0.1273	0.1157	0.1447	0.1124	0.1872	0.1141	0.2190	0.1228
6		0.1539	0.1491	0.1678	0.1447	0.2000	0.1422	0.2290	0.1470
4		0.1895	0.1911	0.2012	0.1867	0.2232	0.1821	0.2459	0.1828
2		0.2360	0.2420	0.2427	0.2368	0.2547	0.2310	0.2677	0.2280

		Purples							
		2.5P		5.0P		7.5P		10.0P	
V/C	*Y*	*x*	*y*	*x*	*y*	*x*	*y*	*x*	*y*
9/6	76.77					0.3120	0.2788	0.3218	0.2845
4		0.2963	0.2865	0.3003	0.2870	0.3117	0.2928	0.3176	0.2966
2		0.3050	0.3051	0.3067	0.3060	0.3107	0.3081	0.3128	0.3094
8/14	57.59							0.3342	0.2349
12						0.3117	0.2370	0.3312	0.2470
10				0.2870	0.2380	0.3116	0.2497	0.3282	0.2582
8		0.2800	0.2488	0.2914	0.2534	0.3116	0.2626	0.3250	0.2700
6		0.2881	0.2671	0.2963	0.2704	0.3114	0.2785	0.3213	0.2829
4		0.2962	0.2850	0.3012	0.2868	0.3114	0.2915	0.3175	0.2955
2		0.3048	0.3040	0.3065	0.3047	0.3107	0.3070	0.3131	0.3084
7/22	41.95							0.3430	0.1883
20								0.3410	0.1988
18						0.3093	0.1962	0.3391	0.2088
16						0.3099	0.2074	0.3368	0.2192
14				0.2801	0.2068	0.3101	0.2192	0.3341	0.2308
12		0.2664	0.2127	0.2833	0.2197	0.3104	0.2320	0.3314	0.2423
10		0.2729	0.2289	0.2872	0.2343	0.3108	0.2442	0.3288	0.2531
8		0.2799	0.2459	0.2918	0.2504	0.3109	0.2584	0.3256	0.2654
6		0.2873	0.2633	0.2961	0.2663	0.3111	0.2730	0.3221	0.2786
4		0.2950	0.2810	0.3009	0.2831	0.3111	0.2880	0.3181	0.2920
2		0.3031	0.3000	0.3059	0.3010	0.3109	0.3037	0.3138	0.3054
6/26	29.31							0.3457	0.1604
24						0.3058	0.1547	0.3441	0.1698
22						0.3062	0.1638	0.3426	0.1785
20				0.2702	0.1621	0.3069	0.1745	0.3409	0.1882
18		0.2504	0.1658	0.2731	0.1738	0.3075	0.1870	0.3388	0.1995
16		0.2548	0.1768	0.2761	0.1852	0.3080	0.1976	0.3370	0.2095
14		0.2593	0.1909	0.2794	0.1979	0.3084	0.2095	0.3349	0.2203
12		0.2647	0.2052	0.2829	0.2121	0.3090	0.2222	0.3321	0.2329
10		0.2703	0.2204	0.2862	0.2260	0.3092	0.2350	0.3293	0.2450
8		0.2770	0.2372	0.2905	0.2421	0.3099	0.2502	0.3259	0.2584
6		0.2842	0.2550	0.2950	0.2585	0.3101	0.2650	0.3226	0.2716
4		0.2932	0.2759	0.3001	0.2778	0.3107	0.2831	0.3181	0.2871
2		0.3016	0.2960	0.3050	0.2967	0.3107	0.2993	0.3146	0.3018

		Red-Purples							
		2.5RP		5.0RP		7.5RP		10.0RP	
V/C	*Y*	*x*	*y*	*x*	*y*	*x*	*y*	*x*	*y*
9/6	76.77	0.3322	0.2910	0.3431	0.2988	0.3512	0.3052	0.3590	0.3118
4		0.3234	0.3010	0.3301	0.3060	0.3350	0.3099	0.3400	0.3140
2		0.3149	0.3108	0.3172	0.3126	0.3190	0.3141	0.3205	0.3155
8/14	57.59	0.3621	0.2496						
12		0.3552	0.2594	0.3818	0.2742	0.4002	0.2859		
10		0.3479	0.2699	0.3685	0.2828	0.3830	0.2930	0.3983	0.3049
8		0.3406	0.2793	0.3570	0.2900	0.3682	0.2983	0.3800	0.3082
6		0.3327	0.2898	0.3440	0.2978	0.3521	0.3042	0.3600	0.3112
4		0.3239	0.3000	0.3308	0.3052	0.3360	0.3092	0.3412	0.3135
2		0.3154	0.3100	0.3180	0.3120	0.3200	0.3136	0.3218	0.3152
7/20	41.95	0.3811	0.2143						
18		0.3751	0.2241	0.4186	0.2459				
16		0.3688	0.2342	0.4076	0.2540	0.4346	0.2689	0.4648	0.2878
14		0.3620	0.2448	0.3958	0.2628	0.4195	0.2762	0.4456	0.2931
12		0.3555	0.2545	0.3841	0.2710	0.4040	0.2834	0.4260	0.2980
10		0.3487	0.2648	0.3713	0.2798	0.3871	0.2906	0.4040	0.3030
8		0.3417	0.2745	0.3603	0.2869	0.3722	0.2963	0.3851	0.3067
6		0.3338	0.2854	0.3470	0.2949	0.3562	0.3022	0.3648	0.3098
4		0.3254	0.2971	0.3332	0.3032	0.3389	0.3079	0.3446	0.3125
2		0.3170	0.3076	0.3206	0.3104	0.3232	0.3125	0.3258	0.3148
6/24	29.31	0.3927	0.1892						
22		0.3877	0.1978	0.4449	0.2219				
20		0.3833	0.2056	0.4368	0.2283	0.4735	0.2464		
18		0.3773	0.2158	0.4245	0.2382	0.4581	0.2549	0.4961	0.2751
16		0.3718	0.2251	0.4136	0.2467	0.4448	0.2622	0.4781	0.2812
14		0.3652	0.2355	0.4023	0.2552	0.4285	0.2705	0.4552	0.2881
12		0.3582	0.2462	0.3900	0.2646	0.4125	0.2784	0.4360	0.2936
10		0.3509	0.2578	0.3769	0.2738	0.3960	0.2860	0.4150	0.2989
8		0.3437	0.2688	0.3648	0.2820	0.3791	0.2929	0.3930	0.3038
6		0.3362	0.2799	0.3520	0.3904	0.3635	0.2987	0.3740	0.3074
4		0.3272	0.2929	0.3371	0.3001	0.3439	0.3056	0.3508	0.3112
2		0.3188	0.3048	0.3232	0.3085	0.3261	0.3113	0.3292	0.3141

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TABLE 2 *Continued*

		Purples							
		2.5P		5.0P		7.5P		10.0P	
V/C	Y	x	y	x	y	x	y	x	y
5/30	19.24					0.3010	0.1170	0.3490	0.1308
28				0.2618	0.1135	0.3018	0.1253	0.3478	0.1388
26		0.2348	0.1140	0.2635	0.1224	0.3022	0.1331	0.3468	0.1460
24		0.2372	0.1223	0.2652	0.1304	0.3030	0.1423	0.3450	0.1555
22		0.2402	0.1315	0.2673	0.1398	0.3038	0.1500	0.3437	0.1644
20		0.2438	0.1419	0.2694	0.1499	0.3042	0.1606	0.3422	0.1735
18		0.2476	0.1532	0.2718	0.1604	0.3052	0.1711	0.3401	0.1840
16		0.2515	0.1644	0.2744	0.1718	0.3060	0.1830	0.3362	0.1951
14		0.2560	0.1774	0.2775	0.1847	0.3068	0.1951	0.3360	0.2066
12		0.2608	0.1913	0.2806	0.1977	0.3071	0.2080	0.3335	0.2187
10		0.2665	0.2075	0.2845	0.2137	0.3080	0.2230	0.3308	0.2328
8		0.2728	0.2240	0.2885	0.2296	0.3087	0.2375	0.3280	0.2464
6		0.2806	0.2444	0.2932	0.2487	0.3093	0.2555	0.3243	0.2630
4		0.2898	0.2667	0.2986	0.2699	0.3100	0.2750	0.3198	0.2807
2		0.3000	0.2912	0.3045	0.2928	0.3103	0.2959	0.3148	0.2986
4/32	11.71	0.2265	0.0774	0.2574	0.0833	0.2962	0.0906		
30		0.2285	0.0847	0.2588	0.0907	0.2969	0.0979	0.3440	0.1080
28		0.2302	0.0909	0.2600	0.0971	0.2979	0.1062	0.3432	0.1172
26		0.2322	0.0978	0.2618	0.1052	0.2986	0.1135	0.3428	0.1248
24		0.2348	0.1062	0.2635	0.1132	0.2993	0.1225	0.3421	0.1337
22		0.2371	0.1143	0.2652	0.1218	0.3001	0.1306	0.3411	0.1424
20		0.2394	0.1221	0.2670	0.1300	0.3010	0.1396	0.3400	0.1500
18		0.2430	0.1332	0.2693	0.1408	0.3016	0.1500	0.3386	0.1626
16		0.2467	0.1452	0.2718	0.1520	0.3028	0.1621	0.3370	0.1756
14		0.2509	0.1585	0.2747	0.1660	0.3035	0.1755	0.3351	0.1875
12		0.2559	0.1730	0.2778	0.1808	0.3045	0.1905	0.3331	0.2014
10		0.2619	0.1903	0.2814	0.1967	0.3056	0.2060	0.3306	0.2162
8		0.2685	0.2089	0.2855	0.2150	0.3066	0.2228	0.3280	0.2318
6		0.2763	0.2300	0.2903	0.2347	0.3076	0.2416	0.3248	0.2493
4		0.2855	0.2531	0.2958	0.2565	0.3084	0.2622	0.3210	0.2686
2		0.2962	0.2807	0.3022	0.2825	0.3093	0.2859	0.3162	0.2902
3/34	6.396	0.2230	0.0543						
32		0.2242	0.0587	0.2557	0.0630				
30		0.2252	0.0638	0.2568	0.0690	0.2922	0.0750		
28		0.2268	0.0698	0.2579	0.0750	0.2930	0.0812		
26		0.2286	0.0765	0.2590	0.0822	0.2938	0.0892	0.3343	0.0978
24		0.2305	0.0832	0.2602	0.0891	0.2944	0.0967	0.3341	0.1055
22		0.2329	0.0911	0.2620	0.0978	0.2953	0.1057	0.3340	0.1146
20		0.2354	0.1003	0.2639	0.1074	0.2961	0.1151	0.3332	0.1240
18		0.2380	0.1094	0.2657	0.1163	0.2969	0.1239	0.3329	0.1332
16		0.2410	0.1198	0.2680	0.1272	0.2981	0.1356	0.3320	0.1456
14		0.2449	0.1325	0.2707	0.1397	0.2992	0.1475	0.3309	0.1572
12		0.2498	0.1480	0.2739	0.1539	0.3003	0.1618	0.3301	0.1715
10		0.2548	0.1638	0.2772	0.1707	0.3020	0.1794	0.3286	0.1889
8		0.2615	0.1845	0.2819	0.1910	0.3037	0.1981	0.3269	0.2075
6		0.2691	0.2072	0.2870	0.2135	0.3057	0.2208	0.3243	0.2293
4		0.2792	0.2342	0.2928	0.2386	0.3072	0.2448	0.3214	0.2517
2		0.2922	0.2680	0.2997	0.2700	0.3088	0.2740	0.3170	0.2790
2/30	3.056	0.2231	0.0432						
28		0.2245	0.0491	0.2559	0.0525				
26		0.2260	0.0555	0.2569	0.0594				
24		0.2277	0.0621	0.2582	0.0669	0.2882	0.0719		
22		0.2298	0.0696	0.2597	0.0750	0.2890	0.0799	0.3230	0.0861
20		0.2320	0.0779	0.2612	0.0838	0.2902	0.0901	0.3231	0.0962
18		0.2345	0.0873	0.2632	0.0935	0.2912	0.0995	0.3233	0.1063
16		0.2372	0.0980	0.2652	0.1045	0.2922	0.1106	0.3235	0.1181
14		0.2406	0.1100	0.2676	0.1163	0.2938	0.1235	0.3235	0.1317
12		0.2449	0.1245	0.2709	0.1320	0.2956	0.1392	0.3233	0.1477
10		0.2501	0.1422	0.2748	0.1500	0.2979	0.1569	0.3230	0.1659
8		0.2570	0.1635	0.2791	0.1707	0.3000	0.1781	0.3219	0.1862
6		0.2661	0.1921	0.2850	0.1992	0.3025	0.2058	0.3207	0.2132
4		0.2758	0.2208	0.2908	0.2261	0.3048	0.2321	0.3189	0.2390
2		0.2892	0.2583	0.2984	0.2612	0.3071	0.2647	0.3161	0.2691

		Red-Purples							
		2.5RP		5.0RP		7.5RP		10.0RP	
V/C	Y	x	y	x	y	x	y	x	y
5/26	19.24	0.4011	0.1652						
24		0.3965	0.1738	0.4683	0.1978				
22		0.3924	0.1814	0.4581	0.2068	0.5045	0.2248		
20		0.3873	0.1909	0.4484	0.2150	0.4915	0.2330	0.5396	0.2535
18		0.3821	0.2007	0.4372	0.2242	0.4761	0.2421	0.5185	0.2620
16		0.3763	0.2108	0.4261	0.2331	0.4617	0.2506	0.4986	0.2695
14		0.3703	0.2211	0.4142	0.2428	0.4454	0.2596	0.4767	0.2776
12		0.3635	0.2325	0.4022	0.2523	0.4303	0.2675	0.4579	0.2841
10		0.3560	0.2452	0.3880	0.2630	0.4108	0.2773	0.4332	0.2918
8		0.3490	0.2570	0.3748	0.2729	0.3932	0.2852	0.4105	0.2980
6		0.3396	0.2718	0.3585	0.2842	0.3726	0.2941	0.3851	0.3039
4		0.3298	0.2869	0.3421	0.2954	0.3515	0.3024	0.3594	0.3090
2		0.3199	0.3019	0.3256	0.3065	0.3296	0.3098	0.3332	0.3131
4/26	11.71	0.4048	0.1428						
24		0.4011	0.1504						
22		0.3967	0.1593	0.4656	0.1821				
20		0.3926	0.1679	0.4571	0.1906	0.5130	0.2101	0.5674	0.2319
18		0.3865	0.1802	0.4455	0.2023	0.4965	0.2217	0.5466	0.2424
16		0.3807	0.1923	0.4339	0.2139	0.4799	0.2329	0.5234	0.2530
14		0.3748	0.2039	0.4225	0.2249	0.4629	0.2437	0.5020	0.2623
12		0.3683	0.2162	0.4104	0.2361	0.4450	0.2541	0.4789	0.2717
10		0.3608	0.2301	0.3960	0.2489	0.4259	0.2651	0.4528	0.2811
8		0.3533	0.2438	0.3833	0.2600	0.4072	0.2750	0.4282	0.2890
6		0.3442	0.2595	0.3671	0.2733	0.3850	0.2859	0.3999	0.2972
4		0.3340	0.2770	0.3491	0.2872	0.3612	0.2963	0.3715	0.3042
2		0.3231	0.2951	0.3310	0.3010	0.3371	0.3061	0.3417	0.3106
3/22	6.396	0.4018	0.1304						
20		0.3969	0.1413	0.4577	0.1593				
18		0.3929	0.1506	0.4503	0.1695	0.5130	0.1893		
16		0.3876	0.1629	0.4418	0.1809	0.4991	0.2011	0.5628	0.2241
14		0.3818	0.1758	0.4313	0.1944	0.4831	0.2140	0.5380	0.2369
12		0.3754	0.1898	0.4199	0.2089	0.4654	0.2273	0.5139	0.2489
10		0.3681	0.2054	0.4073	0.2235	0.4445	0.2419	0.4851	0.2618
8		0.3598	0.2233	0.3930	0.2395	0.4234	0.2556	0.4552	0.2741
6		0.3501	0.2425	0.3765	0.2569	0.3990	0.2708	0.4218	0.2864
4		0.3400	0.2624	0.3586	0.2742	0.3739	0.2851	0.3889	0.2969
2		0.3272	0.2861	0.3370	0.2940	0.3450	0.3001	0.3526	0.3068
2/20	3.056	0.3802	0.1080						
18		0.3778	0.1188	0.4338	0.1340				
16		0.3748	0.1310	0.4269	0.1454	0.4744	0.1595		
14		0.3711	0.1449	0.4180	0.1598	0.4624	0.1737	0.5129	0.1888
12		0.3668	0.1618	0.4080	0.1764	0.4481	0.1903	0.4911	0.2060
10		0.3617	0.1800	0.3971	0.1939	0.4321	0.2082	0.4678	0.2237
8		0.3555	0.2003	0.3858	0.2140	0.4137	0.2276	0.4428	0.2419
6		0.3470	0.2259	0.3708	0.2380	0.3918	0.2490	0.4139	0.2608
4		0.3382	0.2496	0.3558	0.2597	0.3702	0.2683	0.3850	0.2778
2		0.3279	0.2754	0.3383	0.2829	0.3459	0.2892	0.3532	0.2957

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TABLE 2 *Continued*

		Purples										Red-Purples							
		2.5P		5.0P		7.5P		10.0P				2.5RP		5.0RP		7.5RP		10.0RP	
V/C	*Y*	*x*	*y*	*x*	*y*	*x*	*y*	*x*	*y*	*V/C*	*Y*	*x*	*y*	*x*	*y*	*x*	*y*	*x*	*y*
1/26	1.176	0.2251	0.0355																
24		0.2266	0.0418																
22		0.2279	0.0473	0.2590	0.0509														
20		0.2295	0.0542	0.2601	0.0586	0.2831	0.0625												
18		0.2312	0.0618	0.2612	0.0667	0.2841	0.0706	0.3069	0.0748										
16		0.2331	0.0696	0.2625	0.0746	0.2852	0.0790	0.3078	0.0839	1/16	1.176	0.3368	0.0902						
14		0.2361	0.0810	0.2645	0.0863	0.2868	0.0903	0.3084	0.0952	14		0.3368	0.1020	0.3811	0.1138				
12		0.2394	0.0940	0.2670	0.1006	0.2884	0.1059	0.3094	0.1110	12		0.3361	0.1181	0.3772	0.1283	0.4240	0.1400	0.4668	0.1514
10		0.2441	0.1112	0.2701	0.1178	0.2905	0.1229	0.3102	0.1282	10		0.3354	0.1351	0.3727	0.1458	0.4132	0.1580	0.4521	0.1710
8		0.2496	0.1303	0.2742	0.1375	0.2932	0.1429	0.3114	0.1481	8		0.3342	0.1551	0.3660	0.1662	0.4005	0.1793	0.4357	0.1921
6		0.2570	0.1559	0.2794	0.1628	0.2960	0.1682	0.3126	0.1737	6		0.3321	0.1811	0.3588	0.1920	0.3865	0.2036	0.4151	0.2169
4		0.2668	0.1874	0.2854	0.1927	0.2991	0.1974	0.3132	0.2032	4		0.3290	0.2095	0.3503	0.2196	0.3705	0.2300	0.3920	0.2423
2		0.2808	0.2296	0.2936	0.2330	0.3030	0.2361	0.3132	0.2404	2		0.3240	0.2459	0.3378	0.2542	0.3498	0.2617	0.3629	0.2710

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TABLE 3 The CIE (Y, x, y) Equivalents of the Recommended Munsell Renotation for 40 hues, 4 Values, and 6 Chromas Up to the Theoretical Pigment Maximum

		Reds							
		2.5R		5.0R		7.5R		10.0R	
V/C	Y	x	y	x	y	x	y	x	y
0.8/8	0.924	0.483	0.195	0.536	0.214	0.584	0.234	0.635	0.259
6		0.455	0.219	0.496	0.237	0.534	0.255	0.578	0.280
4		0.421	0.245	0.450	0.261	0.477	0.276	0.508	0.296
3		0.400	0.259	0.423	0.275	0.441	0.288	0.461	0.304
2		0.381	0.272	0.399	0.286	0.411	0.297	0.423	0.309
1		0.348	0.294	0.357	0.302	0.362	0.308	0.367	0.314
0.6/8	0.685	0.489	0.176	0.551	0.197	0.604	0.214	0.660	0.235
6		0.464	0.200	0.514	0.221	0.558	0.240	0.605	0.261
4		0.432	0.227	0.469	0.246	0.502	0.264	0.537	0.284
3		0.412	0.244	0.440	0.261	0.467	0.278	0.493	0.296
2		0.391	0.260	0.411	0.274	0.431	0.290	0.447	0.305
1		0.356	0.286	0.365	0.294	0.375	0.305	0.382	0.314
0.4/6	0.456	0.477	0.170	0.537	0.190	0.588	0.208	0.649	0.229
4		0.450	0.198	0.498	0.219	0.539	0.238	0.582	0.258
3		0.430	0.218	0.469	0.238	0.503	0.256	0.537	0.275
2		0.411	0.236	0.441	0.255	0.466	0.272	0.490	0.289
1		0.371	0.270	0.386	0.283	0.399	0.294	0.409	0.305
0.2/3	0.228	0.470	0.162	0.527	0.183	0.581	0.203	0.637	0.226
2		0.451	0.183	0.501	0.204	0.543	0.224	0.592	0.246
1		0.404	0.230	0.435	0.249	0.458	0.265	0.484	0.284

		Yellow-reds							
		2.5YR		5.0YR		7.5YR		10.0YR	
V/C	Y	x	y	x	y	x	y	x	y
0.8/6	0.924	0.637	0.320						
4		0.558	0.330	0.612	0.376				
3		0.495	0.334	0.529	0.372	0.554	0.409		
2		0.445	0.333	0.463	0.361	0.475	0.386	0.481	0.411
1		0.376	0.327	0.384	0.342	0.386	0.351	0.386	0.360
0.6/6	0.685	0.693	0.303						
4		0.603	0.322						
3		0.542	0.330	0.601	0.372				
2		0.474	0.332	0.505	0.367	0.526	0.397	0.551	0.444
1		0.394	0.328	0.403	0.345	0.408	0.359	0.410	0.374
0.4/4	0.456	0.665	0.298						
3		0.606	0.314						
2		0.534	0.324	0.585	0.367				
1		0.428	0.327	0.448	0.354	0.462	0.379	0.471	0.407
0.2/2	0.228	0.679	0.290						
1		0.526	0.317	0.584	0.366				

		Yellows							
		2.5Y		5.0Y		7.5Y		10.0Y	
V/C	Y	x	y	x	y	x	y	x	y
0.8/2	0.924	0.479	0.439	0.465	0.457	0.434	0.460	0.397	0.448
1		0.381	0.370	0.372	0.375	0.359	0.375	0.346	0.371
0.6/2	0.685							0.432	0.501
1		0.404	0.388	0.388	0.394	0.374	0.392	0.356	0.385
0.4/1	0.456	0.468	0.432	0.445	0.444	0.411	0.436	0.379	0.422

		Green-yellows							
		2.5GY		5.0GY		7.5GY		10.0GY	
V/C	Y	x	y	x	y	x	y	x	y
0.8/6	0.924							0.150	0.791
4						0.305	0.613	0.254	0.537
3		0.418	0.564	0.363	0.524	0.313	0.481	0.280	0.447
2		0.363	0.425	0.336	0.410	0.314	0.394	0.298	0.381
1		0.335	0.364	0.322	0.357	0.312	0.351	0.306	0.346
0.6/4	0.685							0.208	0.652
3						0.304	0.561	0..263	0.499
2		0.377	0.468	0.342	0.442	0.315	0.420	0.292	0.399
1		0.338	0.376	0.325	0.367	0.314	0.359	0.304	0.351
0.4/3	0.456							0.204	0.645
2				0.358	0.528	0.312	0.482	0.277	0.445
1		0.350	0.404	0.331	0.391	0.315	0.379	0.299	0.365
0.2/2	0.228							0.185	0.676
1		0.394	0.522	0.349	0.485	0.308	0.449	0.285	0.423

TABLE 3 *Continued*

		Greens							
		2.5G		5.0G		7.5G		10.0G	
V/C	Y	x	y	x	y	x	y	x	y
0.8/6	0.924	0.102	0.660	0.082	0.553	0.073	0.476	0.070	0.408
4		0.225	0.488	0.205	0.447	0.191	0.414	0.178	0.382
3		0.262	0.424	0.247	0.403	0.236	0.385	0.224	0.366
2		0.287	0.371	0.280	0.363	0.272	0.355	0.265	0.346
1		0.300	0.341	0.296	0.338	0.293	0.335	0.289	0.332
0.6/4	0.685	0.175	0.561	0.152	0.493	0.137	0.440	0.124	0.339
3		0.241	0.465	0.221	0.431	0.204	0.400	0.190	0.370
2		0.281	0.388	0.270	0.376	0.259	0.363	0.247	0.349
1		0.300	0.348	0.294	0.343	0.289	0.338	0.283	0.332
0.4/3	0.456	0.166	0.564	0.143	0.499	0.126	0.442	0.112	0.390
2		0.258	0.423	0.239	0.399	0.226	0.380	0.213	0.361
1		0.292	0.360	0.283	0.351	0.276	0.344	0.270	0.338
0.2/2	0.228	0.144	0.584	0.117	0.516	0.097	0.458	0.080	0.397
1		0.266	0.403	0.255	0.390	0.241	0.375	0.229	0.358

		Blue-greens							
		2.5BG		5.0BG		7.5BG		10.0BG	
V/C	Y	x	y	x	y	x	y	x	y
0.8/6	0.924	0.070	0.341	0.072	0.275	0.077	0.233	0.086	0.199
4		0.163	0.342	0.150	0.299	0.145	0.264	0.146	0.237
3		0.209	0.338	0.196	0.308	0.187	0.281	0.183	0.258
2		0.253	0.332	0.241	0.315	0.230	0.296	0.223	0.280
1		0.283	0.325	0.276	0.316	0.270	0.308	0.266	0.300
0.6/4	0.685	0.117	0.341	0.112	0.284	0.113	0.254	0.116	0.221
3		0.177	0.339	0.164	0.299	0.160	0.275	0.160	0.249
2		0.236	0.334	0.221	0.311	0.213	0.295	0.206	0.276
1		0.277	0.326	0.269	0.316	0.264	0.309	0.258	0.300
0.4/4	0.456							0.074	0.187
3		0.103	0.335	0.102	0.278	0.106	0.247	0.116	0.217
2		0.196	0.332	0.180	0.298	0.173	0.275	0.169	0.249
1		0.259	0.326	0.248	0.310	0.242	0.300	0.236	0.284
0.2/2	0.228	0.068	0.332	0.066	0.261	0.072	0.226	0.085	0.195
1		0.210	0.330	0.191	0.295	0.183	0.275	0.176	0.251

		Blues							
		2.5B		5.0B		7.5B		10.0B	
V/C	Y	x	y	x	y	x	y	x	y
0.8/6	0.924	0.094	0.181	0.106	0.163	0.115	0.153	0.128	0.145
4		0.149	0.222	0.154	0.207	0.160	0.196	0.168	0.187
3		0.182	0.246	0.184	0.231	0.187	0.221	0.192	0.212
2		0.220	0.271	0.218	0.258	0.220	0.249	0.222	0.241
1		0.264	0.295	0.262	0.289	0.262	0.283	0.263	0.278
0.6/6	0.685			0.088	0.145	0.099	0.136	0.115	0.128
4		0.123	0.202	0.134	0.187	0.143	0.178	0.153	0.172
3		0.162	0.233	0.167	0.217	0.172	0.206	0.178	0.197
2		0.202	0.260	0.202	0.245	0.204	0.235	0.209	0.227
1		0.255	0.291	0.252	0.282	0.252	0.275	0.254	0.268
0.4/4	0.456	0.087	0.172	0.102	0.159	0.113	0.151	0.126	0.145
3		0.123	0.203	0.133	0.190	0.141	0.180	0.151	0.172
2		0.169	0.236	0.172	0.223	0.176	0.213	0.183	0.203
1		0.233	0.275	0.232	0.267	0.232	0.259	0.234	0.251
0.2/3	0.228					0.097	0.133	0.112	0.127
2		0.097	0.177	0.111	0.164	0.121	0.157	0.133	0.149
1		0.175	0.239	0.178	0.226	0.182	0.216	0.188	0.206

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TABLE 3 *Continued*

V/C	Y	2.5PB x	2.5PB y	5.0PB x	5.0PB y	7.5PB x	7.5PB y	10.0PB x	10.0PB y
		Purple-blues							
0.8/8	0.924	0.117	0.105	0.139	0.102	0.179	0.104	0.220	0.112
6		0.142	0.138	0.160	0.132	0.194	0.131	0.229	0.137
4		0.178	0.181	0.192	0.174	0.216	0.170	0.242	0.170
3		0.200	0.205	0.212	0.200	0.231	0.194	0.252	0.194
2		0.225	0.234	0.234	0.226	0.247	0.221	0.263	0.219
1		0.265	0.273	0.269	0.268	0.275	0.264	0.283	0.262
0.6/8	0.685			0.131	0.088	0.176	0.092	0.216	0.098
6		0.131	0.122	0.152	0.118	0.188	0.117	0.225	0.124
4		0.166	0.165	0.182	0.160	0.208	0.155	0.237	0.157
3		0.188	0.190	0.201	0.185	0.222	0.180	0.246	0.178
2		0.215	0.221	0.223	0.215	0.239	0.208	0.257	0.204
1		0.257	0.263	0.260	0.260	0.268	0.254	0.278	0.250
0.4/8	0.456					0.165	0.072	0.206	0.078
6		0.113	0.098	0.135	0.095	0.175	0.095	0.212	0.100
4		0.141	0.139	0.161	0.134	0.192	0.130	0.223	0.131
3		0.163	0.165	0.179	0.158	0.204	0.153	0.230	0.151
2		0.190	0.196	0.202	0.188	0.220	0.180	0.241	0.176
1		0.238	0.246	0.244	0.239	0.253	0.234	0.265	0.228
0.2/6	0.228					0.159	0.061	0.206	0.064
4		0.109	0.094	0.133	0.090	0.171	0.087	0.213	0.088
3		0.129	0.121	0.150	0.115	0.181	0.108	0.219	0.106
2		0.147	0.143	0.165	0.136	0.192	0.130	0.227	0.126
1		0.196	0.200	0.207	0.193	0.224	0.186	0.248	0.180

V/C	Y	2.5P x	2.5P y	5.0P x	5.0P y	7.5P x	7.5P y	10.0P x	10.0P y
		Purples							
0.3/8	0.924	0.248	0.120	0.275	0.127	0.291	0.132	0.308	0.137
6		0.255	0.144	0.279	0.151	0.294	0.156	0.309	0.162
4		0.264	0.174	0.283	0.179	0.298	0.184	0.310	0.189
3		0.270	0.196	0.286	0.202	0.301	0.206	0.312	0.210
2		0.277	0.220	0.292	0.224	0.304	0.228	0.312	0.232
1		0.291	0.262	0.300	0.264	0.307	0.266	0.312	0.269
0.6/8	0.685	0.244	0.104	0.270	0.110	0.288	0.115	0.304	0.119
6		0.250	0.129	0.274	0.136	0.292	0.141	0.306	0.145
4		0.258	0.160	0.280	0.166	0.296	0.170	0.308	0.174
3		0.264	0.181	0.282	0.184	0.298	0.189	0.310	0.193
2		0.272	0.205	0.287	0.207	0.301	0.211	0.311	0.214
1		0.286	0.250	0.295	0.251	0.306	0.254	0.312	0.256

TABLE 3 *Continued*

V/C	Y	2.5P x	2.5P y	5.0P x	5.0P y	7.5P x	7.5P y	10.0P x	10.0P y
		Purples							
0.4/8	0.456	0.233	0.082	0.260	0.087	0.280	0.091	0.298	0.095
6		0.238	0.104	0.265	0.110	0.284	0.114	0.302	0.119
4		0.246	0.134	0.272	0.138	0.289	0.142	0.304	0.146
3		0.252	0.153	0.276	0.157	0.292	0.161	0.306	0.165
2		0.259	0.177	0.281	0.182	0.296	0.185	0.309	0.189
1		0.276	0.226	0.291	0.228	0.303	0.230	0.312	0.234
0.2/8	0.228	0.232	0.052	0.264	0.056	0.277	0.058	0.291	0.060
6		0.236	0.067	0.266	0.072	0.280	0.074	0.293	0.075
4		0.241	0.090	0.269	0.093	0.283	0.094	0.296	0.097
3		0.245	0.106	0.272	0.109	0.285	0.111	0.298	0.113
2		0.250	0.127	0.275	0.129	0.288	0.131	0.300	0.134
1		0.266	0.180	0.283	0.181	0.295	0.183	0.305	0.185

V/C	Y	2.5RP x	2.5RP y	5.0RP x	5.0RP y	7.5RP x	7.5RP y	10.0RP x	10.0RP y
		Red-purples							
0.8/8	0.924	0.329	0.144	0.362	0.154	0.397	0.165	0.435	0.177
6		0.328	0.168	0.355	0.179	0.384	0.190	0.415	0.203
4		0.326	0.195	0.347	0.206	0.369	0.217	0.393	0.230
3		0.324	0.216	0.342	0.224	0.360	0.234	0.379	0.246
2		0.322	0.236	0.336	0.243	0.350	0.251	0.365	0.261
1		0.317	0.272	0.325	0.276	0.332	0.281	0.339	0.287
0.6/8	0.685	0.326	0.125	0.359	0.135	0.397	0.146	0.434	0.158
6		0.325	0.151	0.354	0.159	0.387	0.170	0.419	0.182
4		0.324	0.179	0.347	0.189	0.373	0.200	0.399	0.211
3		0.323	0.198	0.343	0.207	0.364	0.217	0.386	0.229
2		0.322	0.218	0.337	0.226	0.355	0.236	0.372	0.247
1		0.318	0.259	0.327	0.264	0.336	0.271	0.346	0.278
0.4/8	0.456	0.320	0.100	0.350	0.106	0.391	0.117	0.437	0.128
6		0.320	0.123	0.348	0.131	0.384	0.141	0.423	0.153
4		0.320	0.151	0.344	0.158	0.374	0.169	0.406	0.181
3		0.320	0.170	0.341	0.177	0.368	0.188	0.394	0.200
2		0.320	0.193	0.337	0.199	0.360	0.209	0.381	0.220
1		0.319	0.237	0.328	0.242	0.343	0.251	0.355	0.259
0.2/6	0.228	0.312	0.078	0.342	0.084				
4		0.313	0.100	0.341	0.106	0.381	0.115	0.424	0.125
3		0.314	0.116	0.340	0.122	0.376	0.131	0.415	0.143
2		0.315	0.137	0.337	0.143	0.370	0.152	0.404	0.164
1		0.316	0.188	0.331	0.194	0.353	0.203	0.375	0.214

TABLE 4 CIE Data Converted Graphically to Munsell Notations

CIE Y[A]	CIE x	CIE y	Munsell Notation
59.53	0.2395	0.2905	3.9B 8.11/6.6
80.84	0.3434	0.3025	5.9RP 9.19/6.0
72.22	0.4183	0.3790	5.4YR 8.78/7.6
50.30	0.4690	0.4953	5.6Y 7.56/13.7

[A]The CIE Y value is relative to the perfect reflecting diffuser. For older computer programs in which the CIE Y value is relative to MgO, the CIE Y values become 61.07, 82.84, 74.02 and 51.64 respectively.

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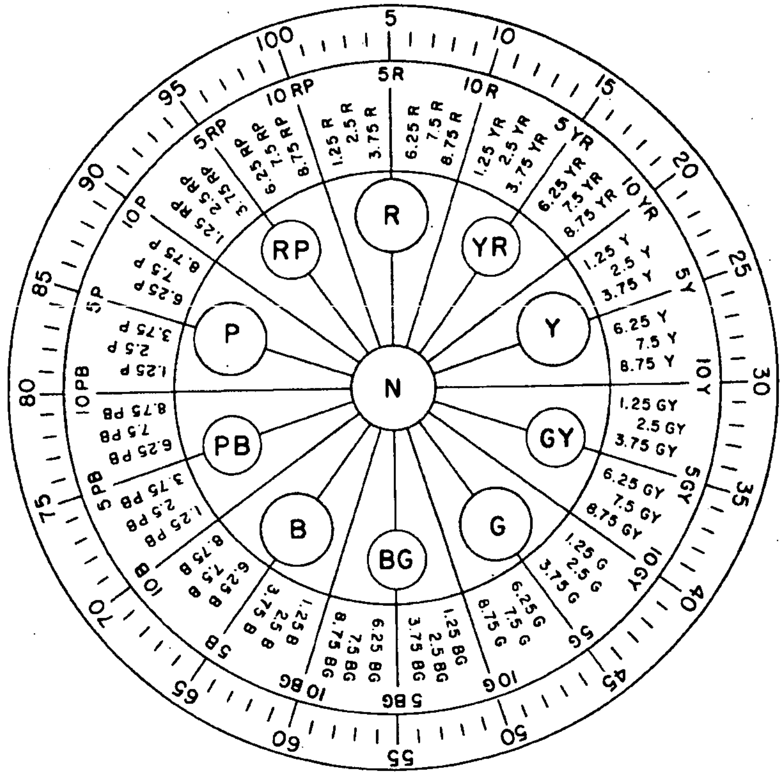

FIG. 1 Designation Systems for Munsell Hue

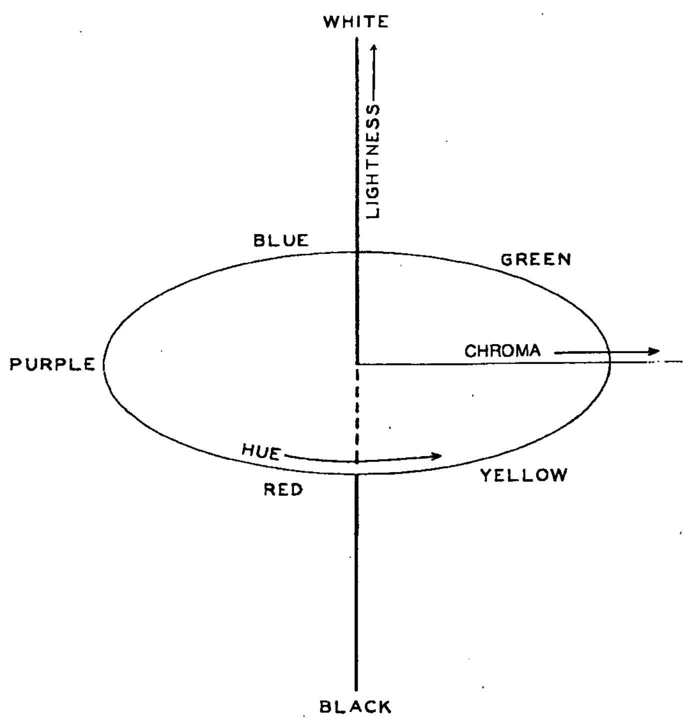

FIG. 2 Dimensions of the Surface-Color-Perception Solid

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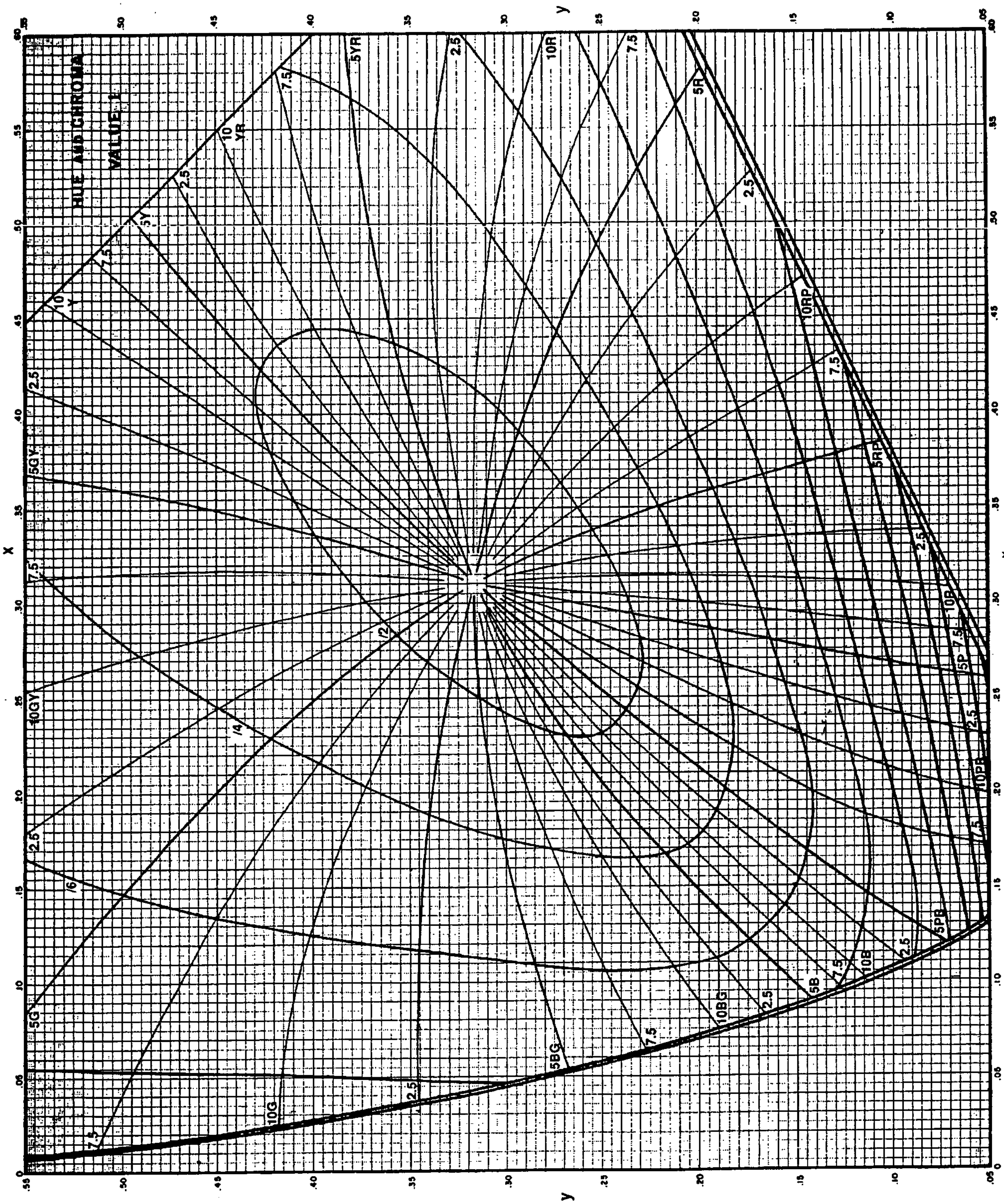

FIG. 3 Munsell Value 1—Loci of Constant Hue and Constant Chroma in CIE (*x, y*) Coordinates

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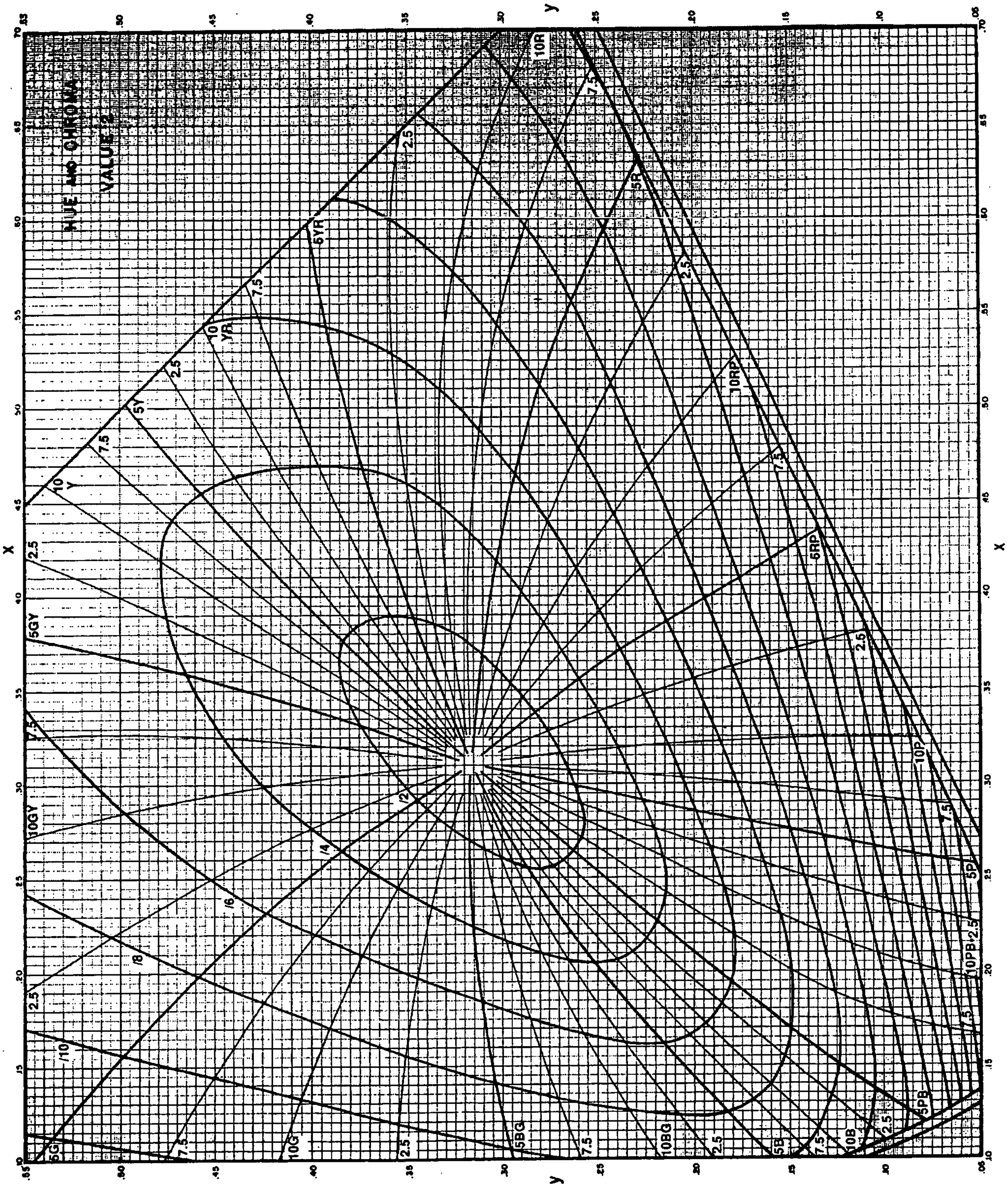

FIG. 4 Munsell Value 2—Loci of Constant Hue and Constant Chroma in CIE (*x*, *y*) Coordinates

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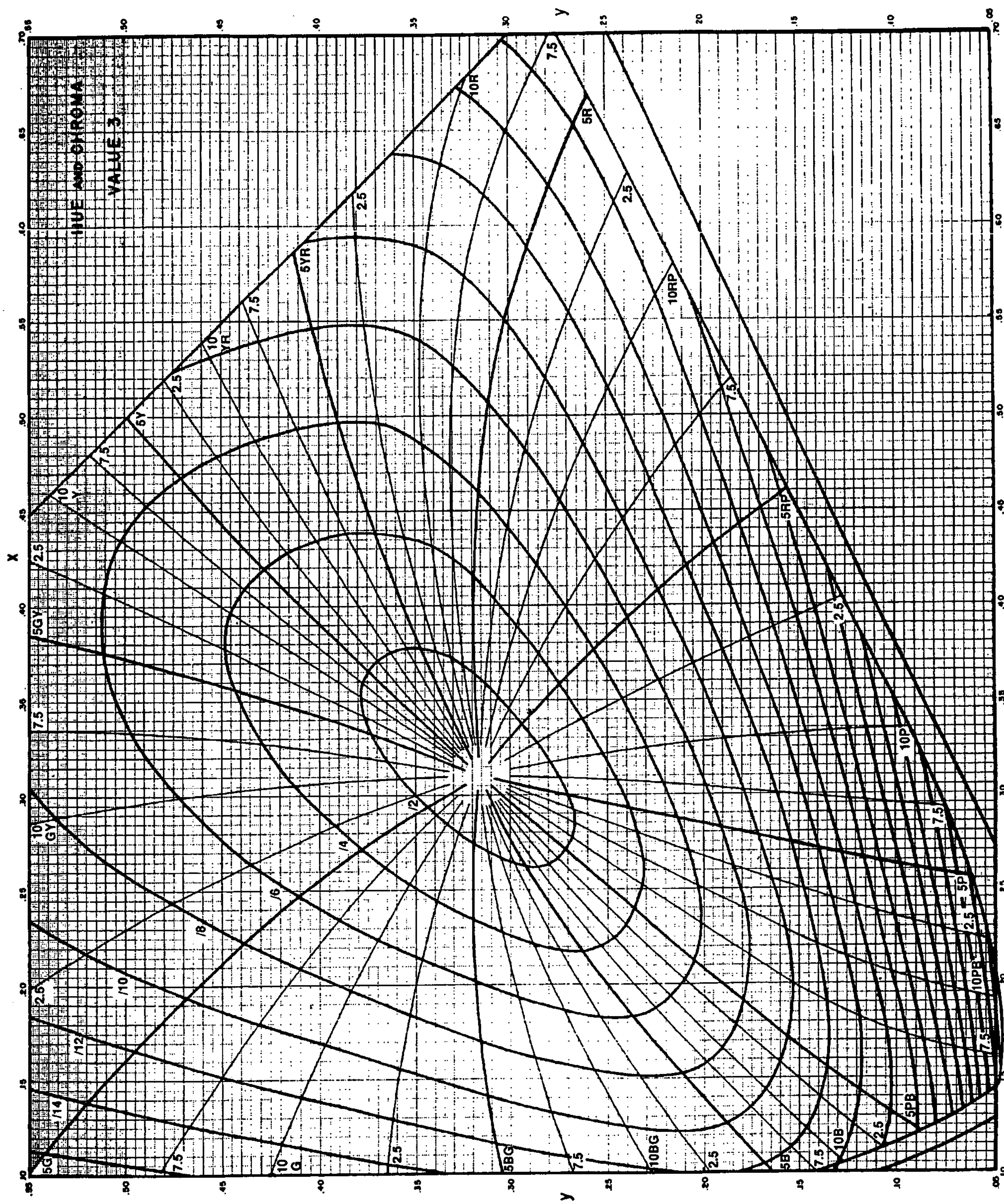

FIG. 5 Munsell Value 3—Loci of Constant Hue and Constant Chroma in CIE (*x*, *y*) Coordinates

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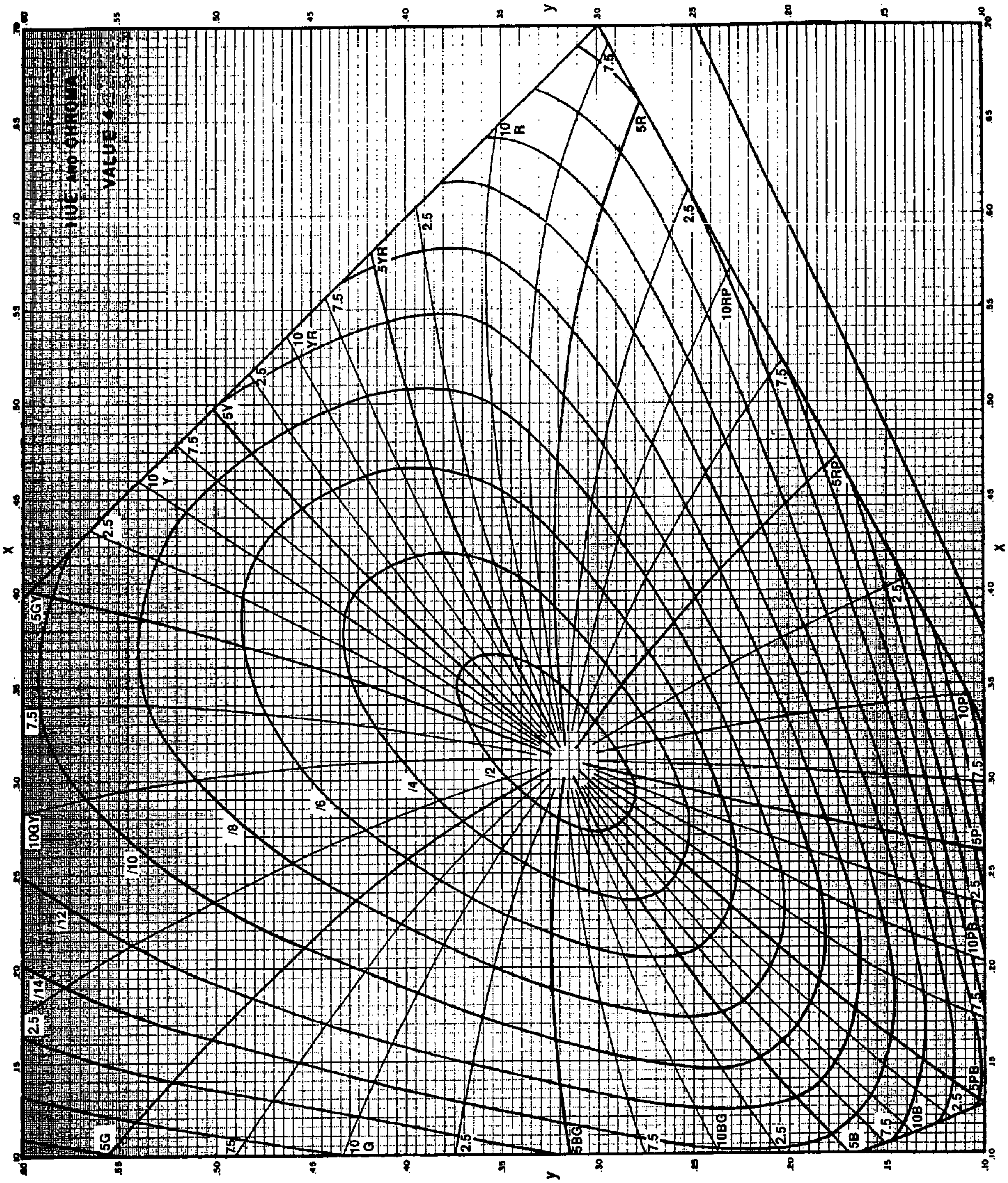

FIG. 6 Munsell Value 4—Loci of Constant Hue and Constant Chroma in CIE (*x*, *y*) Coordinates

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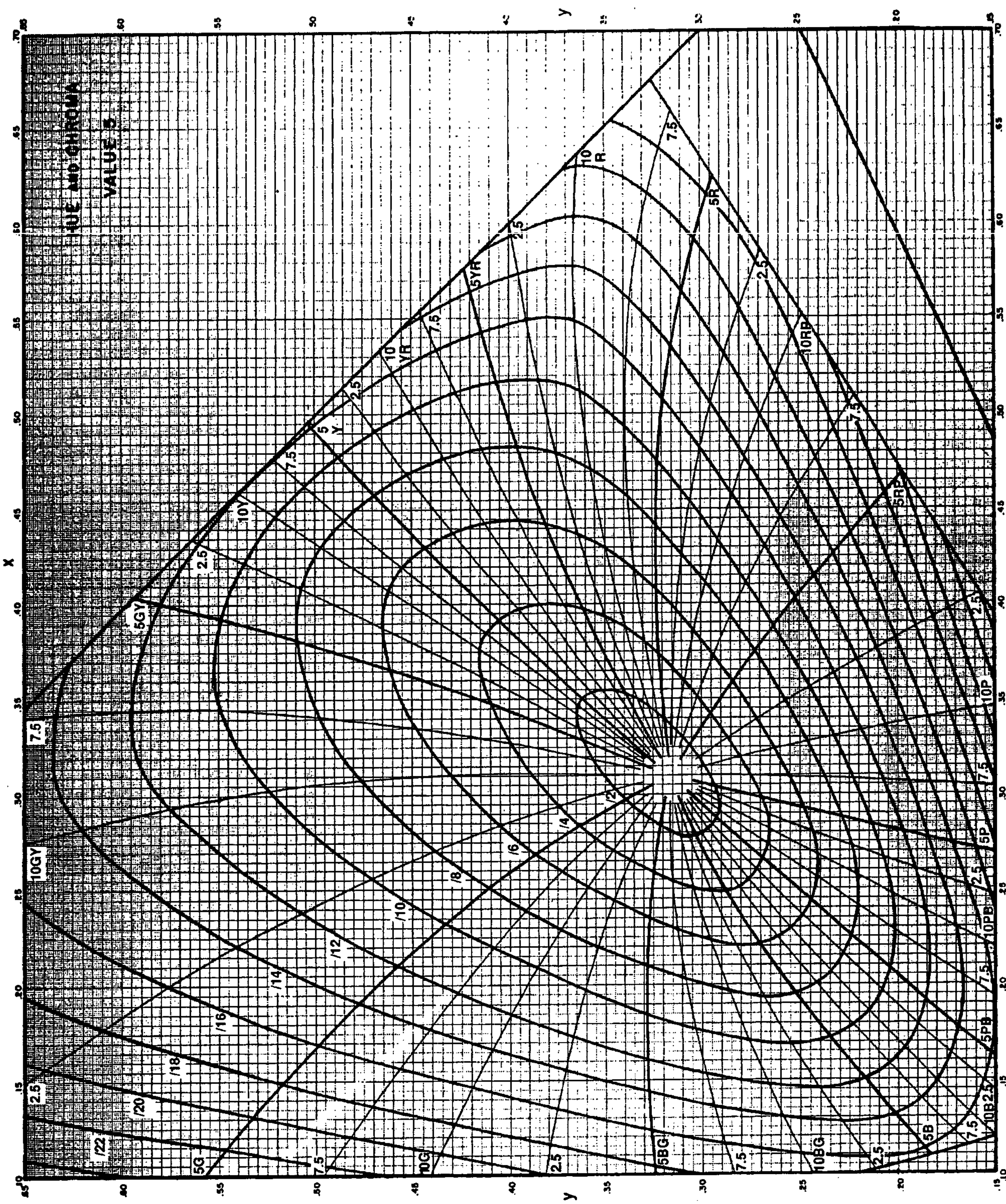

FIG. 7 Munsell Value 5—Loci of Constant Chroma in CIE (*x*,*y*) Coordinates

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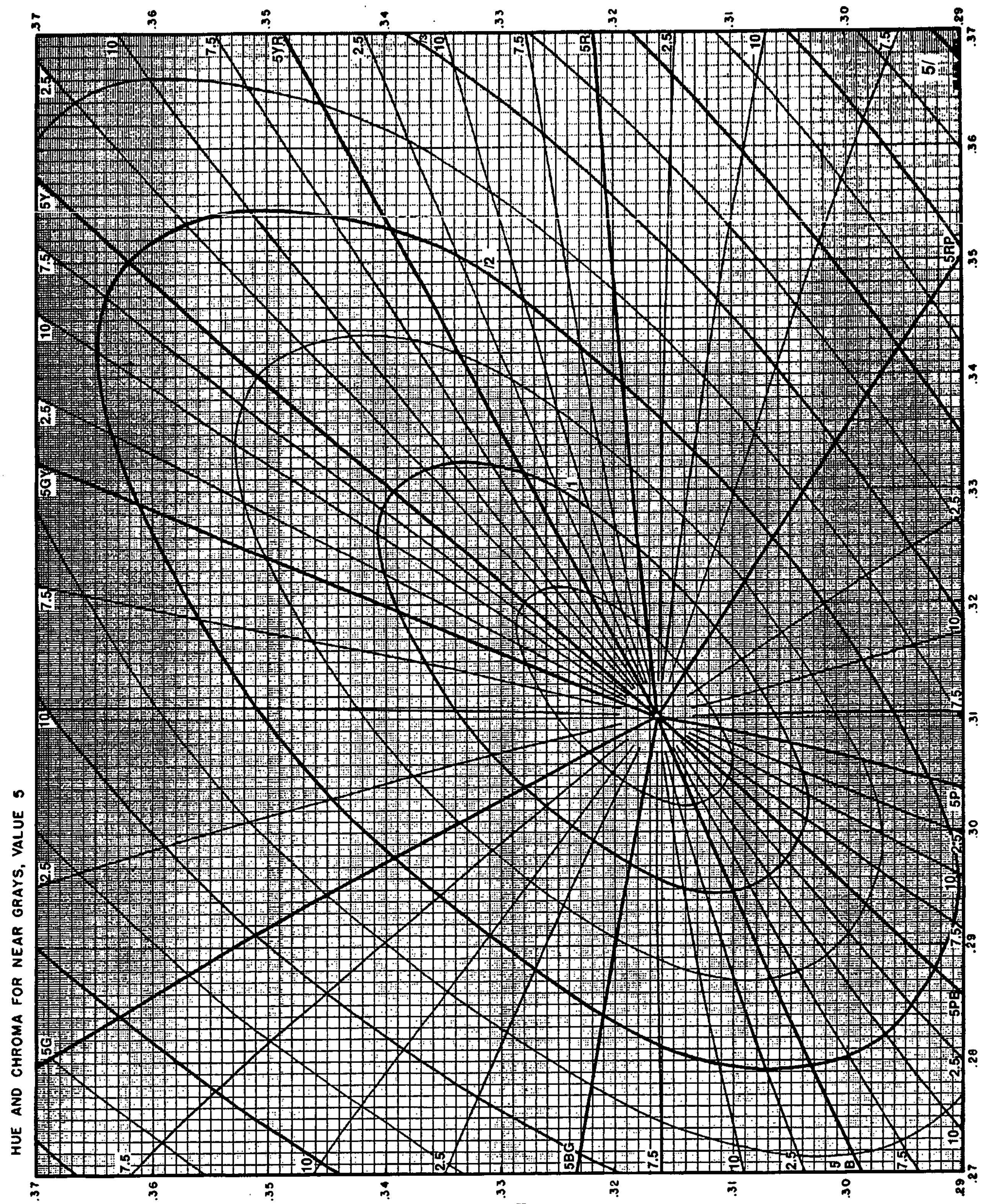

FIG. 8 Munsell Value 5—Loci of Constant Hue and Constant Chroma, Near Gray, in CIE (*x*,*y*) Coordinates

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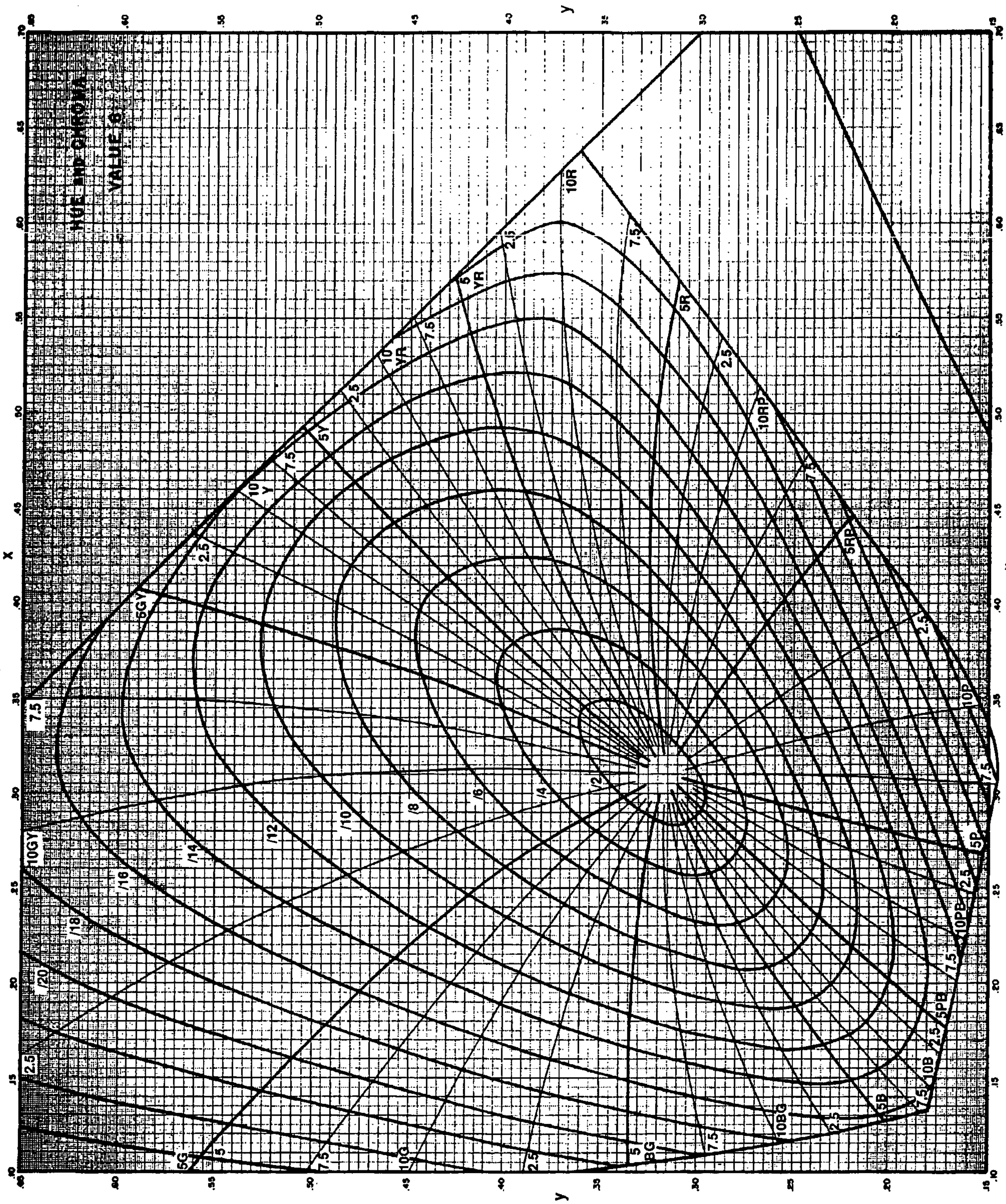

FIG. 9 Munsell Value 6—Loci of Constant Hue and Constant Chroma in CIE (x, y) Coordinates

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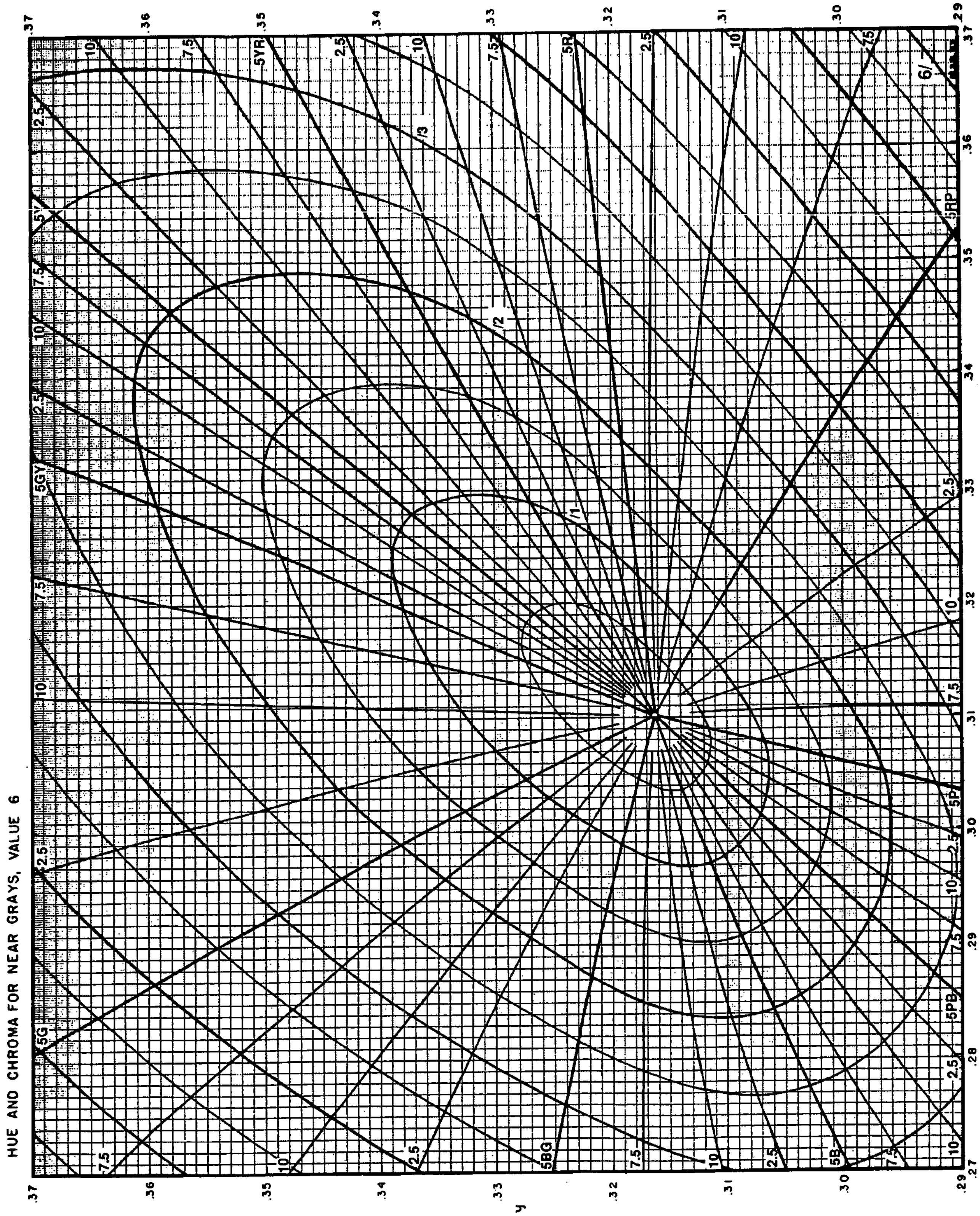

FIG. 10 Munsell Value 6—Loci of Constant Hue and Constant Chroma, Near Gray, in CIE (*x,y*) Coordinates

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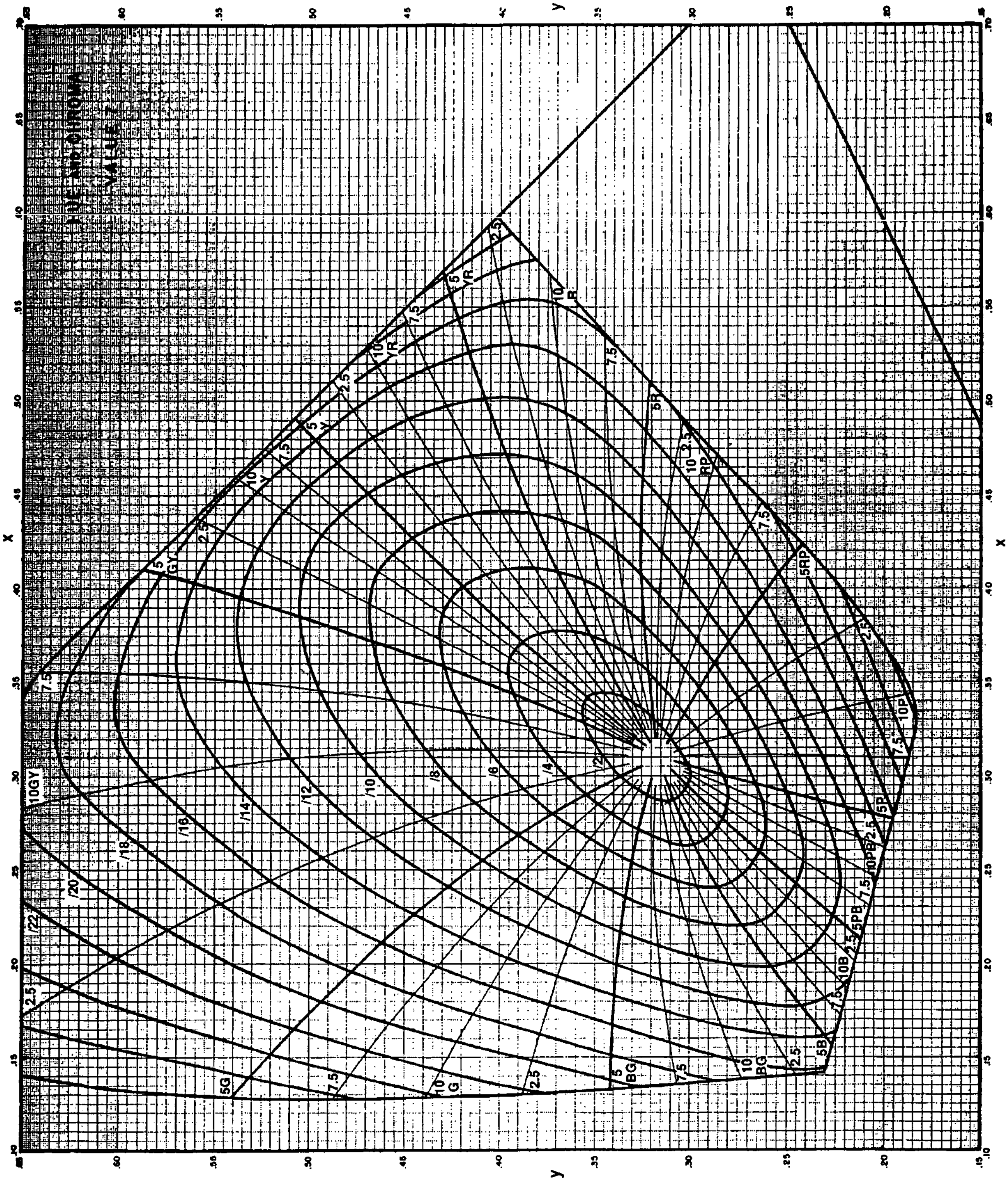

FIG. 11 Munsell Value 7—Loci of Constant Hue and Constant Chroma in CIE (*x*, *y*) Coordinates

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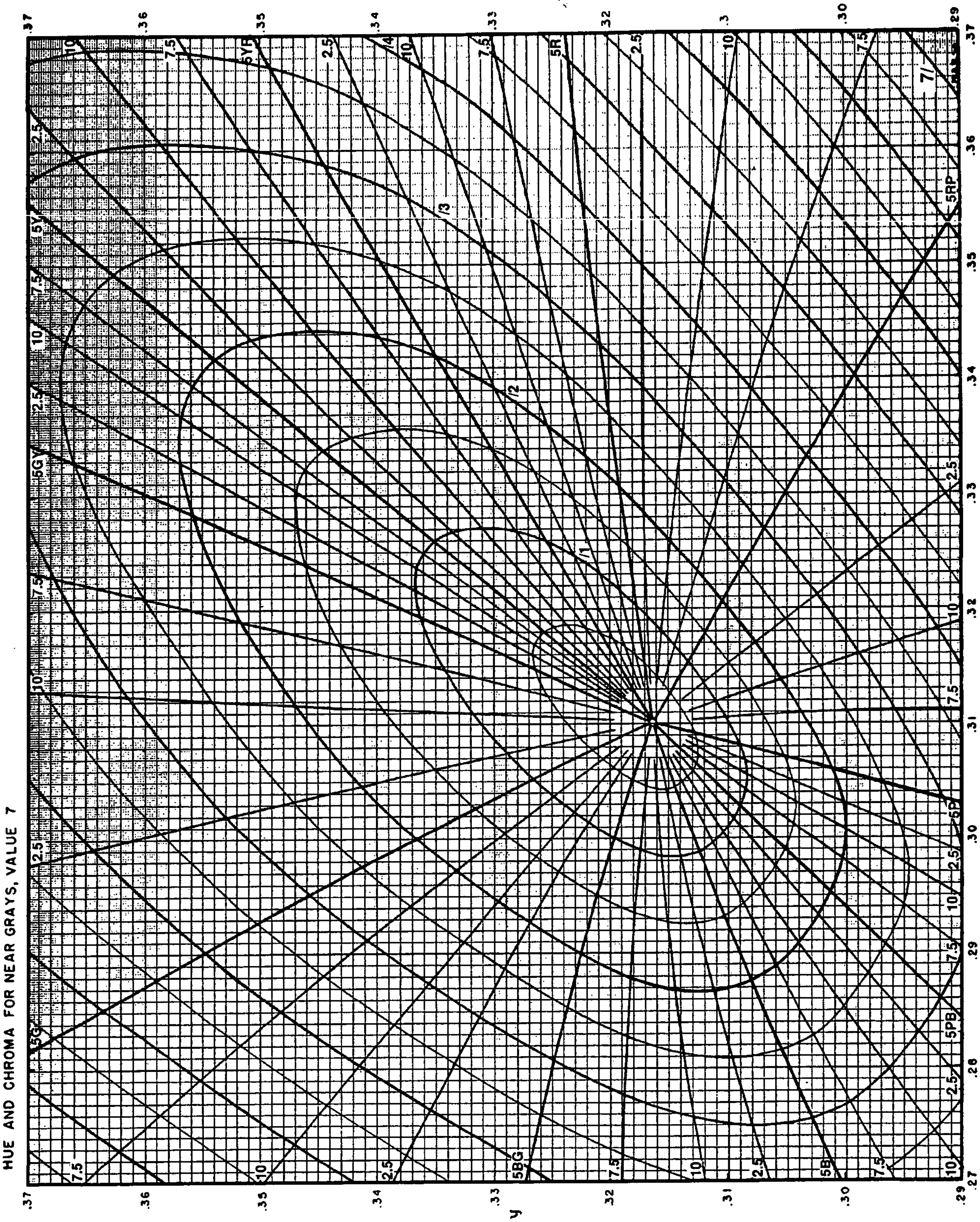

FIG. 12 Munsell Value 7—Loci of Constant Hue and Constant Chroma, Near Gray, in CIE (*x*,*y*) Coordinates

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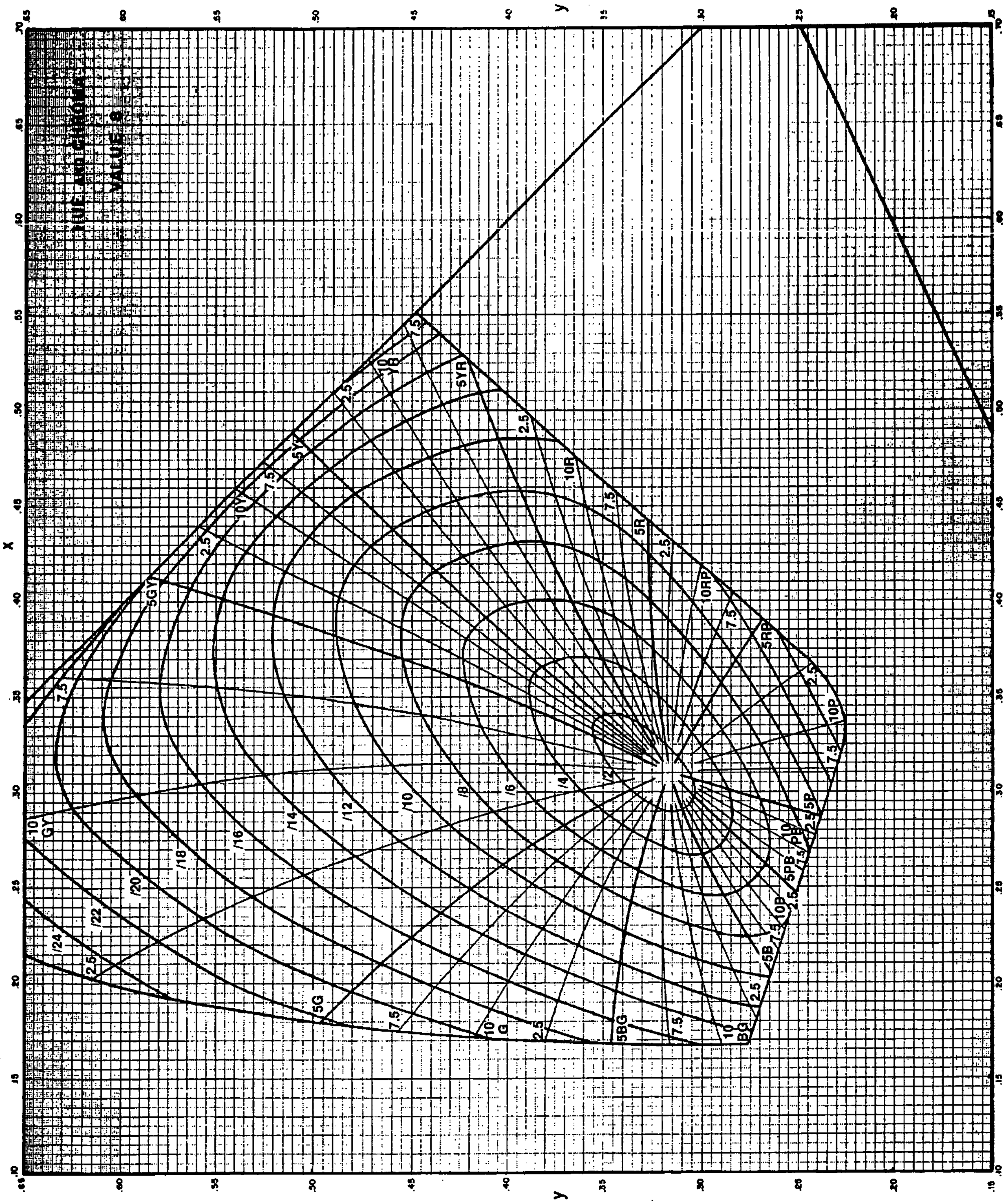

FIG. 13 Munsell Value 8—Loci of Constant Hue and Constant Chroma in CIE (*x*, *y*) Coordinates

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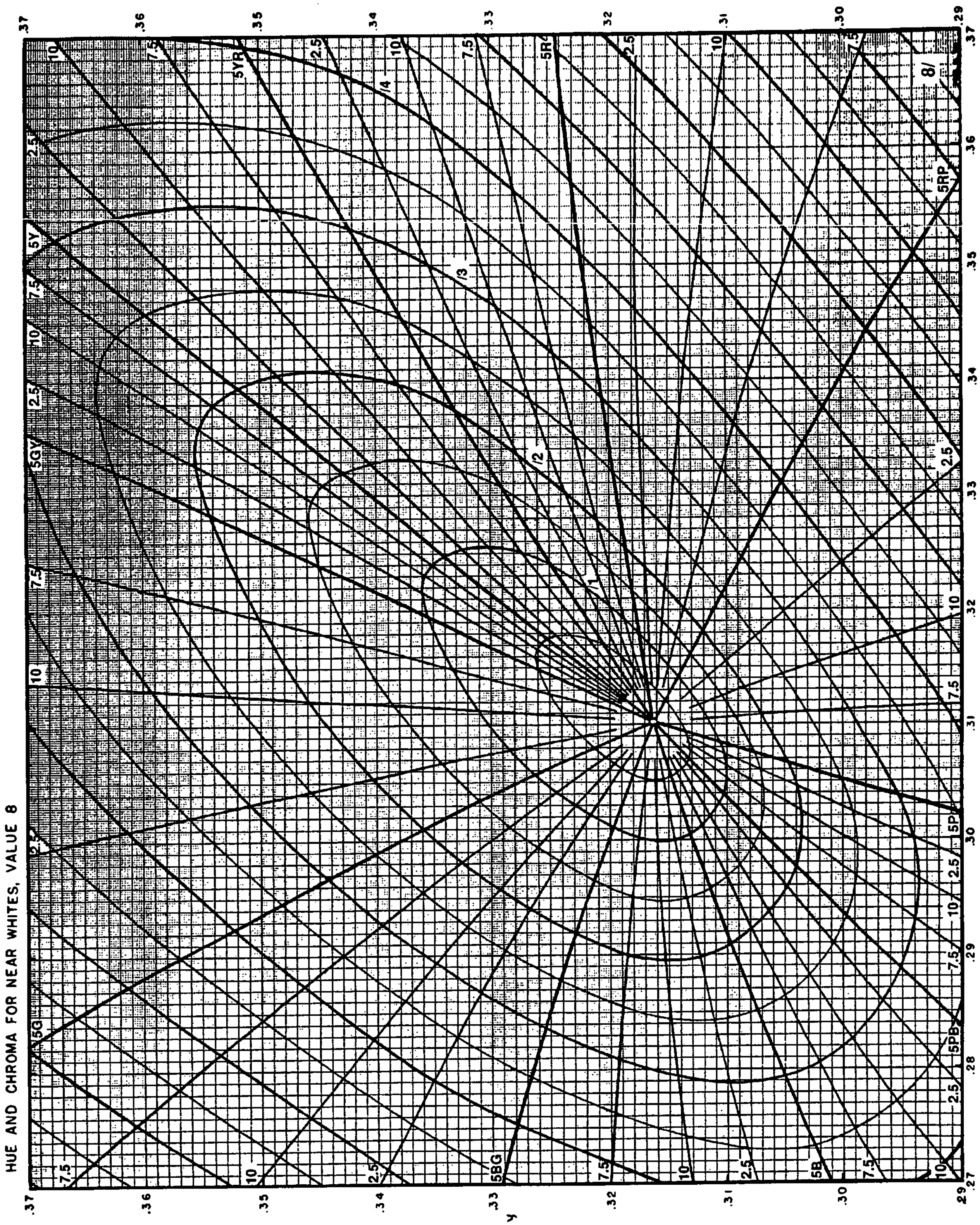

FIG. 14 Munsell Value 8—Loci of Constant Hue and Constant Chroma, Near White, in CIE (*x*,*y*) Coordinates

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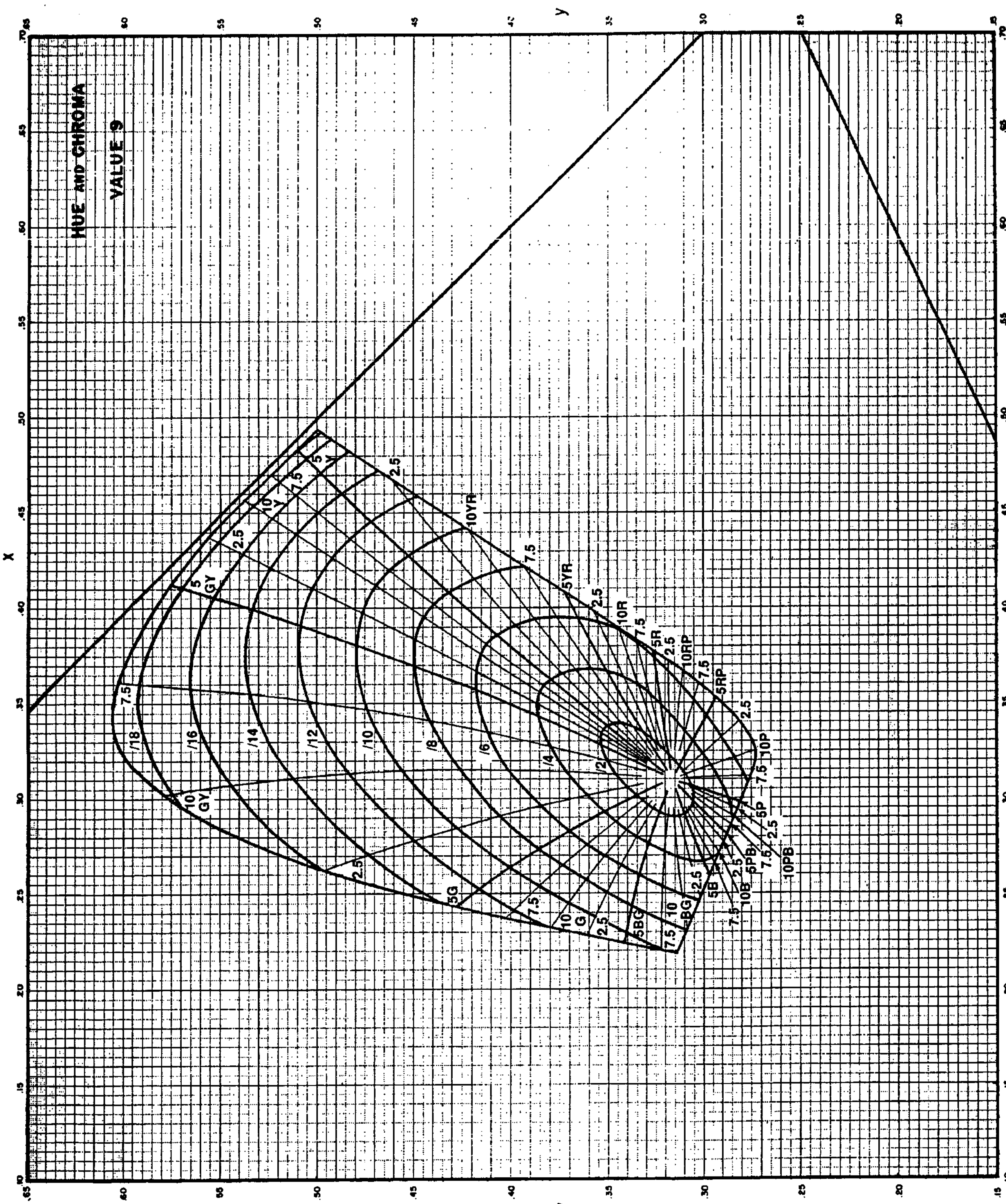

FIG. 15 Munsell Value 9—Loci of Constant Hue and Constant Chroma in CIE (*x*, *y*) Coordinates

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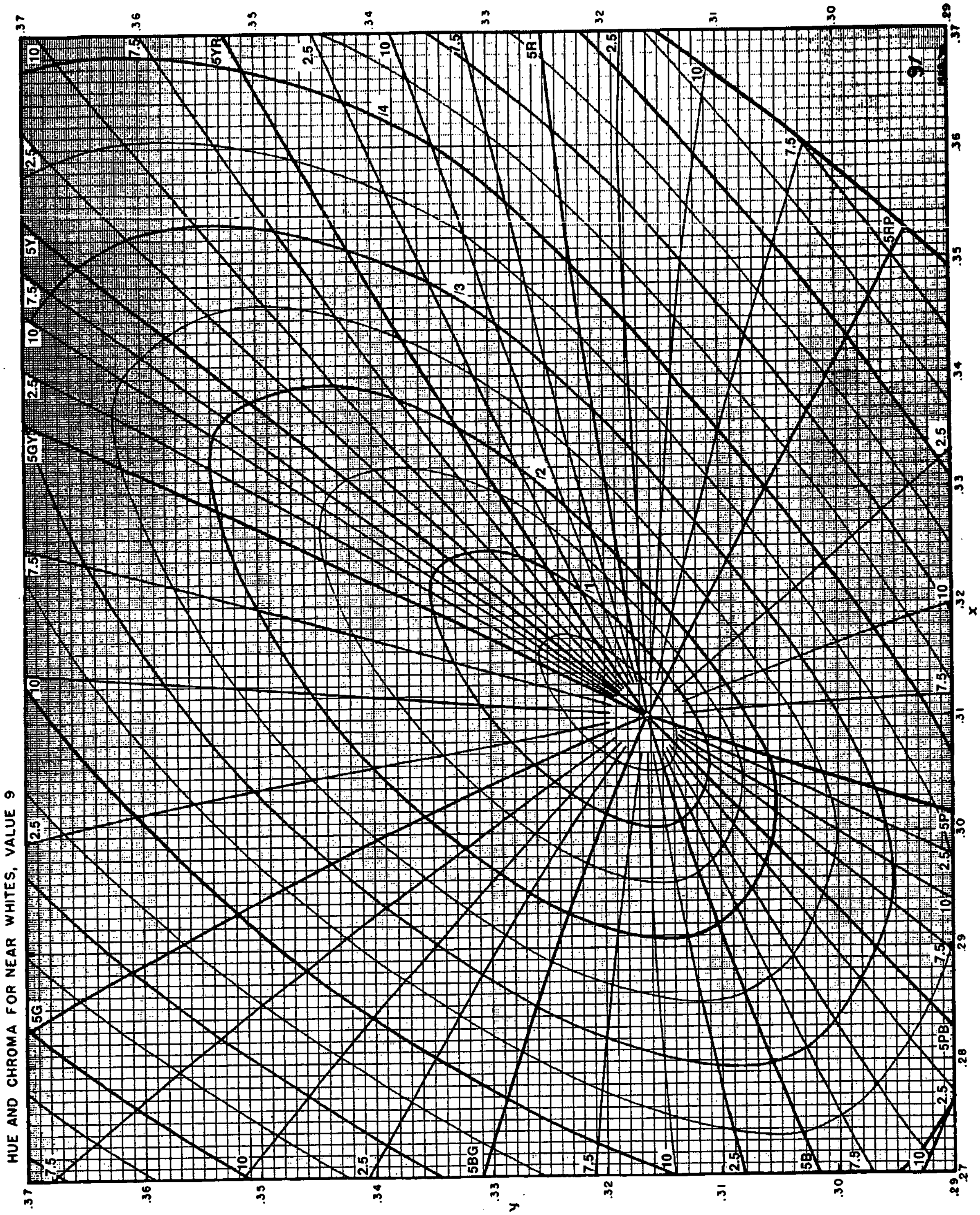

FIG. 16 Munsell Value 9—Loci of Constant Hue and Constant Chroma, Near White, in CIE (*x*,*y*) Coordinates

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Attachment 6

Munsell Color
The Universal Language

For official information on Munsell Color, please visit www.dgcolour.com

The Universal Language

At the beginning of the 20th century, Professor Albert H. Munsell brought clarity to colour communication by establishing an orderly system for accurately identifying every perceptible colour. Today, the Munsell System is recognised around the globe as the standard for colour notation in the worlds of art, business, science, government and education. It is the universal system for selecting, specifying, and controlling colour- in short, the universal language of colour communication.

The Munsell Colour-Order System

The Munsell colour-order system is a way of precisely specifying colours and showing the relationships among colours. Every colour has three qualities or attributes: hue, value and chroma. Munsell established numerical scales with visually uniform steps for each of these attributes. The Munsell Book of Colour displays a collection of coloured chips arranged according to these

scales. Each chip is identified numerically using these scales. The colour of any surface can be identified by comparing it to the chips, under proper illumination and viewing conditions. The colour is then identified by its hue, value and chroma. These attributes are given the symbols H, V, and C and are written in a form H V/C, which is called the "Munsell notation"

Utilising Munsell notations, each colour has a logical relationship to all other colours. This opens up endless creative possibilities in colour choices, as well as the ability to communicate those colour choices precisely.

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Munsell Color

Hue

Hue is that attribute of a colour by which we distinguish red from green, blue from yellow, etc. There is a natural order of hues: red, yellow, green, blue, purple. One can mix paints of adjacent colours in this series to obtain a continuous variation from one colour to the other. For example, red and yellow may be mixed in any proportion to obtain all the hues from red through orange to yellow. The same may he said of yellow and green, green and blue, blue and purple, and purple and red. This series returns to the starting point, so it can be arranged in a circle. Munsell called red, yellow, green, blue, and purple "principal hues " and placed them at equal intervals around this circle. He inserted five intermediate hues: yellow-red, green-yellow, blue-green, purple-blue and red-purple, making ten hues in all. For simplicity, he used the initials as symbols to designate the ten hue sectors: R, YR., Y, GY, G, BG, B, PB, P and RP. The hue circle is illustrated in Figure 1.

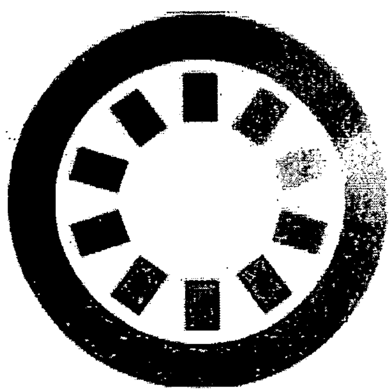

Figure 1: The Hue Circle

Munsell arbitrarily divided the hue circle in to 100 steps of equal visual change in hue, with the zero point at the beginning of the red sector, as shown in Figure 2. Hue may be identified by a number from 0 to 100, as shown in the outer circle. This may be useful for statistical records, cataloguing and computer programming. However, the meaning is more obvious when hue is identified by the hue sector and a step based on a scale of ten, within that sector: For example, the hue in the middle of the red sector is called "five red," and is written "5R" (The zero step is not used, so there is a I OR hue, but no 0 YR.) This method of identifying hue is shown on the inner circle.

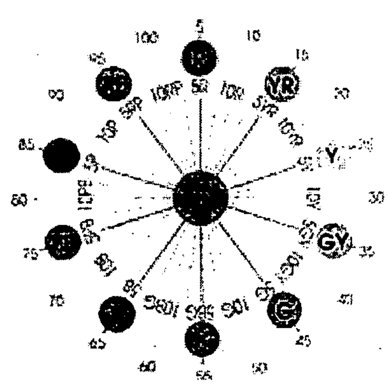

Figure 2: Munsell Hue Designations

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Munsell Color

The Primary Hue Circle

In 1993, Cal McCamy proposed a series of hue names for the hue circle, using the additive primaries - red, green and blue; the subtractive primaries yellow, magenta and cyan; and four intermediate hues. The names are applied to the same set of hue sectors as the Munsell hues. This proposal corrects a well-known displacement of blue on the Munsell hue circle and it accommodates the thinking of the large number of people who work with colour photography, colour printing, colour television, colour copying and colour Computer monitors technologies based on the additive and subtractive primaries. The correspondence between the Munsell hue circle and the primary hue circle is given in Table 1. Blue is the only instance where the same name has a different meaning (resulting from the deliberate use of that name for a different sector). In this case, the new word and symbol are distinguished from the old, when necessary, by the prime mark (Blue' and B').

Munsell Hue Circle		Primary Hue Circle	
Hue	Symbol	Hue	Symbol
Red	R	Red	R
Yellow-Red	YR	Yellow-Red	YR
Yellow	Y	Yellow	Y
Green-Yellow	GY	Green-Yellow	GY
Green	G	Green	G
Blue-Green	C	Cyan	C
Blue	BG	Blue-Cyan	BC
Purple-Blue	PB	Blue	B
Purple	P	Magenta-Blue	MB
Red-Purple	RP	Magenta	M

Table 1: Correspondence between the Munsell Hue Circle and the Primary Hue Circle.

Hue Circle and the Primary Hue Circle

The addition of this set of hue names does not involve any changes whatsoever in the colours in The Munsell book of Colour or any Munsell colour standards. It is merely an alternate way of designating the same hues, in those fields in which it is found useful.

Value

value indicates the lightness of a colour. The scale of value ranges from 0 for pure black to 10 for pure white. Black, white and the Grays between them are called "neutral colours' They have no hue. Colours-s that have a hue are called "chromatic colours The value scale applies to chromatic as well as neutral colours 'The value scale is illustrated for a series of neutral colours in Figure 3.

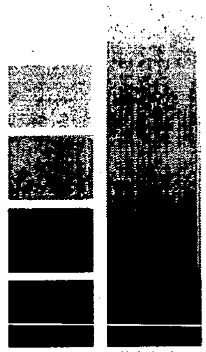

Figure 3: Munsell Value Scale

Chroma

Chroma is the degree of departure of a colour from the neutral colour of the same value. Colours of low Chroma are sometimes called "weak," while those of high Chroma are said to be "highly saturated," "strong" or "vivid" Imagine mixing a little vivid yellow paint with a grey paint of the same value. If you started with grey and gradually added increasing proportions of yellow until the original vivid yellow colour was obtained, you would develop a series of gradually changing colours that increase in Chroma, as shown in Figure 4. The scaling of chroma is intended to be visually uniform and is very nearly so. The units are arbitrary. The scale starts at zero, for- neutral colours, but there is no arbitrary end to the scale. As new pigments have become available, Munsell colour chips of higher chroma have been made for many hues and values. The chroma scale for normal reflecting materials extends beyond 20 in some cases. Fluorescent materials may have chromas as high as 30.

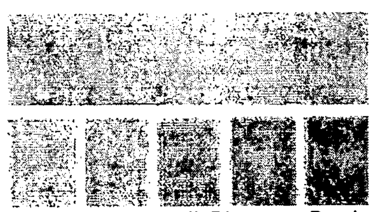

Figure 4: Munsell Chroma Scale

Munsell Color

Munsell Notation

The complete Munsell notation for a chromatic colour is written symbolically: H V/C. For a vivid red having a hue of 5R, a value of 6 and a chroma of 14, the complete notation is 5R 6/14. When a finer division is needed for any of the attributes, decimals are used. For example, 5.3R 6.1/14.4. When the hues of the primary hue circle are used, the notation is written in the same way, for example 2B' 5/4.

The notation for a neutral colour is written: N V/. (The chroma of a neutral colour is zero, but it is customary to omit the zero in the notation.)

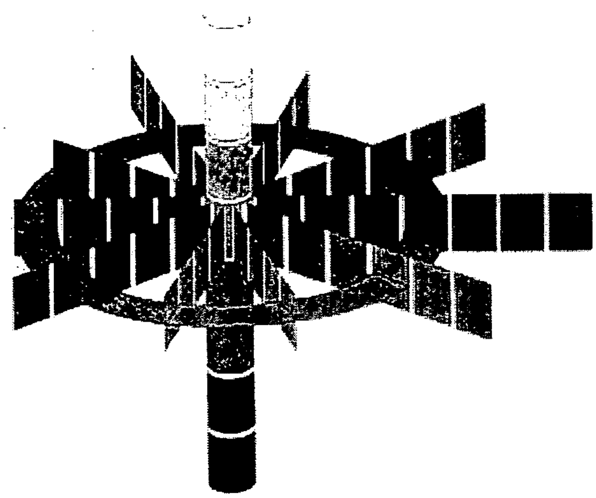

Figure 5: Munsell Colour Space

The notation N 1/ denotes a black, a very dark neutral, while N 9/ denotes a white, a very light neutral. The notation for a middle grey is N 5/.

Munsell Colour Space

Munsell hue, value and chroma can be varied independently so that all colours can be arranged according to the three attributes in a three-dimensional space. The neutral colours are placed along a vertical line, called the "neutral axis," with black at the bottom, white at the top and all Grays in between. The different hues are displayed at various angles around the neutral axis. The chroma scale is perpendicular to the axis, increasing outward. This three dimensional arrangement of colours is called the "Munsell colour space" The relationship of the three scales in three-dimensional space is illustrated in Figure 5.

Munsell Colour Solid

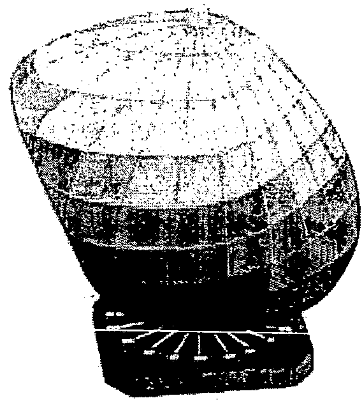

Figure 6: Munsell Colour Solid

All colours lie within a specific region of Munsell colour space called the "Munsell colour solid" Hue is limited to one turn around the circle. The scale of value is limited on the lower end by pure black, which is as dark as a colour can be, and on the top by pure white, which is as light as a colour can be. For a given value, there is a limit to the chroma that is possible, even with theoretically ideal colouring agents. Real colouring agents, with less than ideal characteristics, impose further limitations on physical representations of the colour solid. The Munsell colour order system itself is applicable to all possible colours. The highest chroma yellow colours have rather high values, while the highest chroma blue colours have lower values. Thus the Munsell colour solid has the irregular shape shown in Figure 6.

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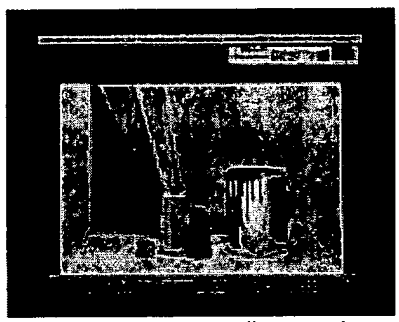
Munsell Color

Standard Viewing Conditions

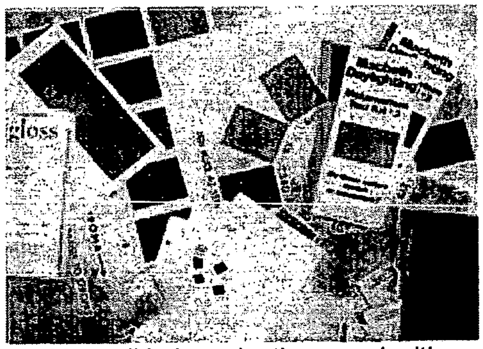
The observed colour of a surface depends on the spectral quality of the illumination, the direction of illumination, the direction of viewing, the surround or background, the nature of any light that might be reflected from the surface and the nature and state of adaptation of the eyes of the observer. The is standard practice to view specimens illuminated by daylight from a lightly overcast north sky (south sky in the southern hemisphere) or the artificial equivalent of this illumination (1)65 daylight source). Viewing booths that provide controlled artificial daylight and other common illuminates are available from Macbeth. Their use is recommended because the light is much more reproducible than natural daylight, they provide standard viewing conditions at any hour, and, in interior rooms they provide a neutral ambient surround and they exclude extraneous light. Specimens should be viewed along their normal (the line of sight perpendicular to the surface) and illuminated at 45° to the normal. equivalent results can be obtained with reversed geometric arrange-illuminating normally and viewing at 45°. These conditions are described in a standard from the American Society for Testing and Materials (ASTM): D1729 Standard Practice for Visual Evaluation of Colour Differences of Opaque Materials.



The Judge II viewing booth from Macbeth features a versatile complement of light sources, including Simulated Daylight D65. It is invaluable for selecting and evaluating colour.

Before anyone is required to judge colours, they should be tested to assure that they have normal colour vision. About one man in twenty and one woman in fifty have defective colour vision, commonly called colour blindness Even among normal observers, there is variation in aptitude for judging colours. Normally this capability gradually diminishes with age. Even among normal expert observers, differences in judgements, due to normal variation in the human eye, are not uncommon. Colour vision can be evaluated by the use of the Farnsworth--Munsell 100 Hue Test, which is available from Macbeth.

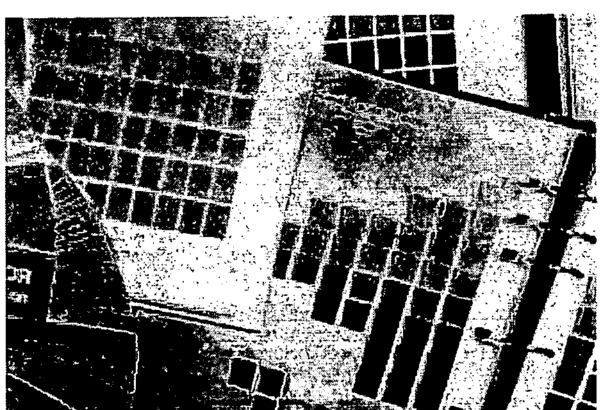
Munsell Color
Development of the Munsell Colour-Order System



Instructional materials from Munsell help make the complexities of colour understandable.

Munsell was an artist and art teacher .He developed the basic principles of the system and published them in a small book, A Colour Notation, in 1905. In 1915, he published The Munsell Atlas of Colour, displaying coloured specimens of a range of values and chromas for ten hues. He formed the Munsell Colour Company to produce colour standards in 1918, but died the same year. His son sponsored studies at the National Bureau of Standards and in the Munsell Colour Laboratory, which led to the improved colour scales in the l929 edition of The Munsell book of colour, which displayed 20 hues.

A subcommittee of the Optical Society of America studied the visual spacing of the scales and published recommended changes in 1943. Those recommendations are called the "Munsell renotation" The recommended spacing was specified by the system of colour measurement standardised by the International Commission on illumination (identified by the initials, CIE, of its name in French), using CIE illuminant C and CIE 1931 (2°) Standard Observer. The renotation provides a method of converting colour measurement data to Munsell notations and provides the specifications for producing Munsell colour standards. The Munsell renotation was standardised by the American Society for Testing and Materials in 1)1535 standard Test Method for Specifying Colour by the Munsell System.



Colours from the Munsell System are available in books and various size. They make it easy to communicate exact color selections to anyone anywhere.

About 1950, the number of hues in The Munsell Book of Colour was doubled, from 20 to 40 hues. In the early editions of the Munsell book of Colour, the chips had a matte surface. In

1958,a glossy version was introduced, to improve the reliability of comparisons of the standards to paints, plastics and other materials with glossy surfaces. Both matte and glossy versions are in widespread use today. The Nearly Neutrals Collection, introduced in 1990, provides a number of pale colours often used for cosmetics, interior design and computer hardware.

The Munsell colour-order system has gained international acceptance. It is described in unabridged dictionaries and encyclopaedias as well as in specialised publications on art, design, colour photography, television, printing, paint, textiles and plastics. It is recognised as a standard system of colour specification in standard Z138.2 of the American National Standards Institute; Japanese Industrial Standard for Colour, JIS Z 8721; the German Standard Colour System, DIN 6164; and several British national standards. in books and various size swatches. They make it The Munsell colour-order system has easy to communicate exact colour selections to anyone, anywhere. been widely used in many fields of colour science, most notably as a model of uniformity for calorimetric spaces and has, itself; been the subject of many scientific studies.

Munsell Color

Munsell and Macbeth

In 1970, the Munsell Colour Company was acquired by Kollmorgen Corporation, the parent company of Macbeth. Macbeth is the only company that offers a complete spectrum of colour matching, colour quality control and process control systems; lighting booths and luminaries; densitometers; and physical colour standards. By completely integrating all aspects of colour management, Macbeth has established itself as the world-wide leader in total colour quality. Today, the Munsell Colour Laboratory is located at Macbeth´s world-wide headquarters in New Windsor, New York.

Special Purpose Standards

Unique colour reference materials play a vital role in science and industry. Examples include Soil Colour Charts and the Colour

Checker chart for assessing colour reproduction.

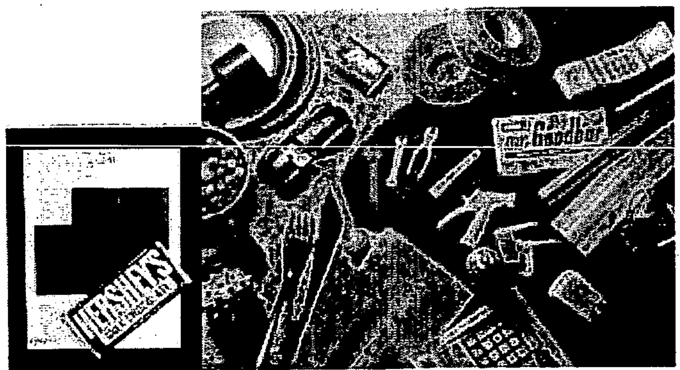
Munsell Colour provides special collections of colours including, Soil Colour (charts for identifying soil colours, the 'ColorChecker' chart for appraising the colour rendition of colour reproduction processes such as photography, electronic publishing, printing and television, and the Farnsworth-Munsell 100 Hue Test for testing colour vision. In addition, Munsell will develop special colour charts to meet your- application.

Munsell Custom Colour Standards

The Munsell Colour Laboratory produces custom standards to meet the needs of industry, commerce and govern. These colour standards are used for products, logos, packaging, foods, interiors and more. They help eliminate costly errors caused by poor colour communication and ensure colour accuracy through every step of production, from colour design and selection to finished product. Standards for gloss and texture can also be established.

Colour Tolerance Sets are the best way to ensure visual control of colour quality of different types of materials, especially when a variety of suppliers are responsible for various parts of a single product. These seven-step cards are used for visual evaluation of colour differences from a specified colour standard. With Munsell's assistance, you determine the acceptable

range of deviation and a tolerance set is created showing the ideal colour plus six others representing the acceptable upper and lower limits for the three dimensions of colour. Even when colour is con-trolled by measurements, a colour tolerance set is a useful aid m visualising colour tolerances and reaching clear understandings among buyers, sellers and producers.



At Munsell, we can match virtually any colour you can see. Our custom colour standards are used for products, logos, packaging, food and more.

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